

ASSOCIATIONS OF EARLY INFANT FEEDING AND ADIPOSITY AMONG SCHOOL-  
AGED CHILDREN

by

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(Under the Direction of Alex Kojo Anderson)

ABSTRACT

The purpose of this study was to examine the role of infant feeding practices on childhood overweight and obesity. The specific aims were to determine the relationship between infant feeding and childhood adiposity and the relationship between the age of introduction to complementary foods and childhood adiposity. Participants in this cross-sectional study ( $n = 27$ ) were mostly white (66.7%), female (88.9%) and the average age was 4.1 years. There was no statistically significant relationship between infant feeding practice and adiposity or between age of introduction to complementary foods and adiposity. There was, however, a significant, positive correlation between the mother's BMI and the birth weight of the child ( $P=.009$ ) and between the mother's current BMI and the child's current weight ( $P=.031$ ). Because of these results, there is a need for research into the role of infant feeding and complementary foods and their impact on childhood obesity.

INDEX WORDS:     Body composition, childhood adiposity, breastfeeding, complementary feeding

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B.S.F.C.S., University Of Georgia, 2011

A Thesis Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment of  
the Requirements for the Degree

MASTER OF SCIENCE

ATHENS, GEORGIA

2013

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## DEDICATION

This work is dedicated to my family and friends who have supported me and encouraged me through these past two years. Thank you for your love, kind words, patience, and understanding.

For Mom, Dad, Michael, Staci, and Jason. Thank you for always believing in me and encouraging me. I could not have done this without your love and support.

And for Kay Norvell, thank you for encouraging me not only to pursue nutrition as a career, but to also get my master's degree. Your encouragement has been instrumental in my academic pursuits.

## ACKNOWLEDGEMENTS

I would like to thank my advisor, Dr. Alex Anderson, for the guidance and support throughout this project. I am grateful for his patience in explaining statistical concepts and for giving me ample opportunities to work on his various research projects. I gained a unique understanding of public health research, and I am thankful for the opportunity to have worked on those projects with you.

I would also like to thank my committee members Dr. Richard Lewis and Dr. Emma Laing for supporting me as I worked through this degree. Dr. Lewis, thank you for always having an open door to me, even as an undergraduate, when I was seeking advice. Dr. Laing, thank you not only for your help in the writing of my thesis, but for also helping me with recruiting participants.

In addition, I would like to thank my lab mates and classmates Anne Armstrong, Kristin Harper, Susannah Gordon, Amy Krauss, Sara Najafi, Stephanie Foss, and Trae Cown. The past two years would not have been the same without you.

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## CHAPTER 1

### INTRODUCTION

Childhood and adolescent obesity rates have been on the rise for the past three decades, and these rates have become one of the major concerns in the healthcare system (1). Data from the National Health and Nutrition Examination Survey from 1999 to 2010 indicates that, 26.7% of pre-school aged children 2 to 5 years of age have BMI-for-age over the 85<sup>th</sup> percentile and 12.1% have BMI-for-age over the 95<sup>th</sup> percentile (1). In 2012, the Centers for Disease Control and Prevention (CDC) published a state report on health statistics, and in this report, 15.8% of Georgia's 2 to 5 year old children were overweight defined as 85<sup>th</sup> to 95<sup>th</sup> percentile of BMI-for-age (2). Also, 13.5% of Georgia's 2 to 5 year old children were obese, or over the 95<sup>th</sup> percentile of BMI-for-age (2). There have been a myriad of contributing factors to the high prevalence of overweight and obesity among pre-school aged children that include, but not limited to the availability of convenience and fast foods, increase in consumption of sugar-sweetened beverages, lower rates of breastfeeding, and lack of physical activity.

Breastfeeding has been reported to promote leanness among young children more so than formula feeding (3, 4). Other studies have observed longer breastfeeding duration to be linked with reduced likelihood of overweight in young children (5,6); however, these studies only used BMI-for-age and skin fold thickness to measure and diagnose overweight and obesity which are not accurate methods of assessing adiposity. This situation has resulted in mixed reporting of the association between breastfeeding and obesity. Measuring adiposity using a valid body composition methodology in studies examining the role of breastfeeding in the obesity epidemic is likely to provide conclusive evidence of the influence of breastfeeding on obesity, particularly in childhood.

Although, there are numerous techniques and equipment for body composition measurement such as underwater weighing, dual energy x-ray absorptiometry, bio-electric impedance and deuterium dilution, the air-displacement plethysmography (ADP) technique has been evaluated and shown to be an accurate, easy and convenient means of measuring percent body fat in infants, children, and adults (7, 8, 9). When compared to other methods of body composition measurement, the ADP systems were just as accurate and unbiased (7). One of the limitations, however, has been in the continuum of testing for different ages. The infant ADP system (PEA POD Body Composition System, COSMED Inc., USA), only measures infants up to 6 months, and the adult ADP system (BOD POD Body Composition System, COSMED Inc., USA) can be challenging when testing young children. This is mostly due to a need for restraint or seating support for young children, and some young children cannot follow the breathing protocol for testing their thoracic volume. Therefore, there has been a knowledge gap in young children for air-displacement plethysmography body composition measurement. Being able to test this age range with the ADP technique is important for consistency and continuity throughout the lifespan.

However, in 2011, COSMED USA released a pediatric option for the BOD POD that measures children between the ages of 2 and 6 years (10). This innovative equipment can help bridge the gap in knowledge by allowing a continuum of testing and monitoring body composition changes over an individual's life using the ADP technique. While it is a new body composition technique, the BOD POD pediatric option has been reported to be as accurate in measuring the body composition of young children as other traditional body composition methods including dual-energy X-ray absorptiometry and total body water (10, 11).

Although many studies have reported breastfeeding to be protective against the risk for overweight and obesity, other studies have not observed this association (12). This discrepancy may be due to different data collection methods and criteria for the assessment of breastfeeding and

obesity used for the various studies. The inconsistency in the literature calls for a more accurate means of assessing adiposity and infant feeding among children. This research project seeks to examine the relationship between infant feeding type, duration of breastfeeding, and age of introduction to solid foods and adiposity in children ages 4 to 6 years.

The first objective for this project is to determine the relationship between infant feeding and childhood adiposity in early childhood. It is hypothesized that children who were exclusively breastfed for at least three months will have a lower overall adiposity compared to children who were mixed-fed because of the protective effects of breastmilk. The second objective is to determine the relationship between the age of introduction to complementary foods and childhood adiposity. It is hypothesized that children who were introduced to complementary foods before the age of 6 months will have higher adiposity.

## CHAPTER 2

### LITERATURE REVIEW

#### **Childhood Obesity Rates**

The prevalence of childhood obesity has increased over the past three decades (1, 13). More recently in 2009 and 2010, the prevalence was reported to have leveled off at about 17% in both children and adolescents (14). The prevalence of childhood overweight and obesity is highest in minority groups, specifically in Hispanic and black children (1). Hispanic males and non-Hispanic black females have the highest prevalence of childhood overweight and obesity at 40.5% and 41.3%, respectively with body mass indexes over the 85<sup>th</sup> percentile on the Centers for Disease Control growth charts (1). Even though the prevalence of obesity has leveled off in recent years (14), the co-morbidities that are associated with overweight and obesity are still detrimental to children's health statuses (1,13-15,41). The likelihood of an obese child becoming an obese adult increases as the child ages, and childhood obesity has been shown to be an underlying factor to obesity in adulthood (13,15). Childhood and adolescent obesity can lead to metabolic syndrome, which is defined by Ferranti et al as high blood pressure above the 90th percentile for age, sex, height; central obesity or waist circumference above the 75th percentile for age and sex; low HDL cholesterol, high fasting glucose, and hypertriglyceridemia (16). Central obesity or abdominal obesity is the most common co-morbidity of high BMI for age in children and adolescents, and it is highly correlated with insulin resistance in children and adolescents (16). Overweight and obesity are the most important risk factors for type 2 diabetes mellitus in children. The prevalence of overweight and obesity and type 2 diabetes parallel one another in children (41-44).

There are also increased risks of some types of cancers in people with high body mass indexes. These cancers include esophageal, gall bladder, endometrial, thyroid, and colon (16). Low serum vitamin D has been associated with overweight and obese children, and low serum vitamin D has also been linked to certain types of cancer, especially colorectal cancer. (17). While many of these were once considered to be exclusively adult diseases, the prevalence of childhood and adolescent overweight and obesity has made them more common in younger people.

### **Benefits of Breastfeeding**

Human breast milk is the optimal nutritional source for infants because its benefits carry throughout a lifetime (3). The Academy of Nutrition and Dietetics declares that breast milk, for the first 6 months of life, is the healthiest and most beneficial source of nutrients for an infant (18). Breast milk provides immunoglobulins from the mother for improved immune health and a reduced solute load that can be easily digested and absorbed by an infant. The long-term effects of breast milk include a reduced risk of asthma, respiratory tract infections, gastroenteritis, and other infections in children (18). Infants who are breastfed are less likely to be readmitted to the hospital post-delivery (47).

Several studies have concluded that breastfed infants have better cognitive function than their formula-fed peers (45,46). One study examined breastfed and formula-fed children at ages 8 and 9 and found children who were breastfed had, on average, higher test scores in reading comprehension, mathematics, and scholastic ability (46). In addition, the follow up of the participants in the Kramer et al (2008) study in the Promotion of Breastfeeding Intervention Trial (PROBIT) in Belarus found that students in the breastfed (or experimental) group scored higher on the Wechsler Abbreviated Scales of Intelligence (WASI) in vocabulary ( $53.5 \pm 11.6$  vs.  $46.9 \pm 11.4$ ) and full-scale IQ ( $109.7 \pm 15.4$  vs.  $101.9 \pm 15.8$ ) than the non-breastfed group. Also, the teachers rated the breastfed group higher in reading and writing performance (45).

Breastfeeding benefits can last into adulthood. Infants who are breastfed have the benefit of a reduced risk of type 2 diabetes, hyperlipidemia, and hypertension (18). Breastfeeding is also reported to have a protective effect on overweight and obesity (3,5,18-22). There have been many suggestions as to why this is true. It has been suggested that mothers who have breastfed their infants have healthier habits and lifestyles that are then passed on to their children. However, there is a relationship between breastfeeding and a reduced risk of overweight independent of the mother's weight, smoking status, or race (22). Breastfeeding helps infants learn to self-regulate feeding, leading to less force-feeding and over-feeding (21,53). The infants who were breastfed have better appetites and less maternal intervention on feeding as toddlers, leading to higher energy intakes. The toddlers with the highest energy intakes are also taller and leaner than their bottle-fed counterparts (21).

Breastfeeding has been shown to reduce the risk of childhood overweight and obesity (3,5,19-20,48). Independent of socio-economic status, maternal weight, and the child's activity level, 9 year-old children in the Growing Up in Ireland Study who had been breastfed were leaner than those who were not (48). In another study, infants of obese and non-obese parents were studied, and at birth, there were no differences between children of obese parents and children of non-obese parents in terms of their body fat (as determined by skin fold thickness). However, at 6 months of life, the number of bottle-fed infants over the 90<sup>th</sup> and 97<sup>th</sup> percentiles for age was higher than their breastfed counterparts, independent of parentage (3). As these children reached 6 years old, the prevalence of obesity grew exponentially in the bottle-fed cohort (3). Another study found that breastfeeding had a protective effect against obesity only in white children whose mothers were non-smokers (5). While many factors contribute to a child's weight status (diet, maternal weight, activity level), breastfeeding has been shown to have a consistent protective effect against overweight and obesity (19-20).



### **Benefits of Longer Duration of Breastfeeding**

Not only is initiation of breastfeeding important, but also the duration can have a positive effect on the child's health (6, 21, 24-27,38,46,48,49). In a study conducted in Germany, researchers found that longer duration of breastfeeding had a protective effect against overweight and obesity (24). The effect was still significant after adjusting for nationality, socioeconomic status, and parental smoking habits (OR 0.66, 95% CI 0.52–0.87). When they controlled for age, sex, and city of residence, breastfed children weighed substantially less than their non-breastfed peers at ages 9-10 (OR 0.55, 95% CI 0.41–0.74) (24). Another small study also showed that breastfed Caucasian infants were less likely to be obese than their non-breastfed counterparts. This study only observed infants who were breastfed for one year, highlighting the importance of longer duration of breastfeeding (21).

In a Meta analysis of observational studies, Harder et al found that longer duration of breastfeeding had a dose dependent association with risk of overweight in adulthood (6). Seventeen studies were analyzed and categorized to find these doses. Less than one month of breastfeeding had an odd's ratio OR=1.0, 95% CI: 0.65, 1.55. Breastfeeding for 1-3 months had an OR=0.81, 95% CI: 0.74, 0.88. Breastfeeding for 4-6 months OR=0.76, 95% CI: 0.67, 0.86. For 7-9 months OR= 0.67, 95% CI: 0.55, 0.82. Finally breastfeeding for longer than 9 months OR=0.68, 95% CI: 0.50, 0.91(6). These categories show the protective effect of longer duration of breastfeeding against overweight (6).

One birth cohort study showed that breastfeeding had an inverse relationship to overweight as defined by BMI, waist circumference, and waist to hip ratio in 18-28 year olds (26). Infants who were breastfed for 6 months were leaner (as defined by BMI, waist circumference, and waist to hip ratio) than formula-fed and mixed-fed infants (26). Another study showed that being breastfed for between 13 and 25 weeks was associated with a 38 percent ( $p < 0.05$ ) reduction in the risk of

obesity, while being breastfed for 26 weeks or more was associated with a 51 percent ( $p < 0.01$ ) reduction in the risk of obesity at nine-years of age (48).

Infants, who are exclusively breastfed for longer durations, and thus not given complementary foods until 6 months of age or later, have been observed to be leaner than those who are not (38, 49-52). One study showed the early introduction of complementary foods can have adverse effect on a child's weight at 7 years old. Children who were fed complementary foods before or at 4 months of age were heavier than those who were introduced between 4 and 6 months and those introduced after 6 months (49). Rapid weight gain has been reported in infants who were given complementary foods before 16 weeks of age (50-52), and continued to weigh more as children (50,51) and later as adults (52).

Not only has breastfeeding been associated with leaner and healthier adults and adolescents, but also it is also associated with better mental status (27,46). In several studies, longer duration of breastfeeding was associated with higher academic achievements (27,46). Infants who were predominantly breastfed for 6 months or longer had higher grades in school at 10 years old than those who did not breastfeed (27). These studies highlight the importance of early infant feeding practices and how they can affect a child's weight status and other health measures.

### **Body Composition**

While BMI is a fair predictor of overweight and obesity, it does not measure a person's body fat percentage. Body fat measurements can often be more informative of a person's health risks than simple weight and height measurements (1-34,54,55). A high body mass index is not always indicative of high body fat percentage. A Swedish study found there was no significant correlation between high BMI and body fat measurements using air displacement plethysmography in four-year-old children. Some children with high BMI had low body fat, and conversely, some with low BMI had high body fat percentage (55).

Because of these discrepancies in anthropometrics and body composition measurements and estimates, direct assessment of body fat is very critical in studies examining the role of infant feeding practices in the obesity epidemic. Table 2.1 displays these discrepancies and describes the study methods used to measure body composition. Dual X-ray absorptiometry (DXA) machines, hydrostatic weighing and skin-fold thickness have been used for many years to estimate body fat. Hydrostatic weighing requires the user to hold his or her breath for a time underwater while being measured. This method was only appropriate for adults who are comfortable to hold their breath while completely submerged in water. DXA is a highly accurate measure of body fat and bone density; however it does have limitations. The subjects must lie perfectly still on the instrument for 6-12 minutes depending on the DXA machine. Children may find it difficult to be still for that long. Because DXA uses x-ray, some people are opposed to being exposed to radiation, even in small amounts, so they would not be comfortable in a DXA. In about the mid 1990s, air displacement plethysmography emerged as a new method of assessing body fat percentage. It does not require a person to hold his or her breath, like in hydrostatic weighing, and it is faster than a DXA machine (29).

For years, the air displacement plethysmography (ADP) machines were only used for infants up to 6 months and persons over the age of 6 (11,29-32,34-37). Several studies have been done to prove the validity of the infant ADP equipment (PEA POD) for body composition measurement in infants up to 6 months (11,29,30,32,35). Some validity studies used deuterium dilution to compare the results of body composition measurement to the ADP equipment (29,30,35) while other compare ADP results to DXA and hydrostatic weighing (29,35,54). The ADP PEA POD was found to be very accurate when compared to each of the body composition tests (29,30,35). Because of the gap in measures of persons from ages 6 months through 4 years, there were thoracic predictions calculated to estimate lung capacity and body volume in a BOD POD (37).

The thoracic gas volume prediction was estimated from adult models, and when used on children were found to be accurate in all age and ethnic groups (37).

The BOD POD has also been proven to be accurate in measuring body composition of older persons (34,54). It has been found to be reliable when measuring body volume and body fat percentage (34) when compared to hydrostatic weighing. One study found that both the ADP and DXA measurements were highly accurate in detecting the increase in fat mass of both males and females (54).

However, until 2011, air displacement plethysmography did not have a protocol for children ages 6 months to 5 years. The BOD POD Pediatric Option uses a specific software that accurately estimate the total volume and body fat percentage of children in that age gap (11,31), so individuals of any age can be accurately measured using ADP. One study recruited children to measure their body composition using deuterium dilution measurements and air displacement plethysmography. In children 5 to 7 years, the BOD POD was found to be just as accurate in estimating body fat as the deuterium dilution measurements (36). The measurements were compared to DXA, deuterium dilution, and hydrostatic weighing and found that the BOD POD Pediatric Option is just as accurate as these other reliable tools (31-32). Fields and Allison (2012) used the four-compartment model for measuring body composition to measure the new BOD POD Pediatric Option in 2 to 6 year olds (31). Because there is evidence that even at two weeks of life, infants born to overweight/obese mothers have higher body fat compared to normal weight mothers, the researchers wanted to see if this trend carried into young childhood (31,56,57). Fields and Allison used the four-compartment model and tested 42 children with an average age of 4.1 years. The new BOD POD Pediatric Option was found to be valid when comparing body fat percent using ADP versus the four-compartment model (31).

Another study looked at the validity of percent body fat from air displacement plethysmography, DXA, skin-fold thickness, and bioelectrical impedance in school-aged children (32). The skin-fold measurements grossly over- and underestimated percent body fat in both males and females, but there was no significant difference between white and black subjects. The bioelectrical impedance tool underestimated percent body fat in both male and female subjects. Overall, ADP was found to be the superior form of body composition testing (32).

Not only is this new ADP option superior because of its accuracy, but it is also more convenient and time-efficient than a deuterium dilution and more time-efficient than a DXA machine. It can be a challenge to get accurate readings using DXA machines with 4 to 6 year olds because it is imperative that they are still throughout the measurement. The BOD POD Pediatric Option takes about 45 second measurements, making it much easier for young children to sit through (31-32).

### **Breastfeeding and Body Composition**

It is important to know how infant feeding practices affect adiposity because using BMI may not provide a true assessment of body fat percent (55). Body fat is reported to be the main predictor of morbidities that are associated with overweight children (38). Several studies have used a DXA machine to study adiposity and infant feeding practices (38-40). One study looked at infant feeding practices, the timing of introduction of complementary foods, and body composition in 5-year-old children. The children were categorized into groups that had never been breastfed, breastfed for less than 4 months and also formula fed, breastfed for greater than 4 months and then formula fed, breastfed for greater than 12 months and not formula fed, and breastfed and introduced to complementary foods before 4 months. They did not find any significant differences in percent body fat between the groups when they were examined in a DXA machine (38). There were still no statistically significant outcomes between the groups when they adjusted for maternal age, obesity,

education, income, participation in the WIC program, maternal smoking habits, marital status, and gestational diabetes (38).

Another study looked at a birth cohort study, the Avon Longitudinal Study of Parents and Children, to examine body fatness in children slightly older (9-10 years of age) and how they were fed as infants. The participants were grouped into categories of never breastfed, breastfed for less than 3 months, breastfed for 3 to 5 months, and breastfed for greater than or equal to 6 months. They found that breastfeeding only had an inverse relationship with high adiposity if continued for more than 6 months (39). Similarly, a prospective study, the Southampton Women's Study, examined body fatness and infant feeding habits of 4-year-old children (40). A total of 539 children participated and were measured in the DXA machine. There were different statistical measurements that divided the participants into those who were never breastfed, breastfed for under one month, breastfed for 1 to 3 months, breastfed for 4 to 6 months, breastfed for 7 to 11 months, and breastfed for a year or longer. Also there were groupings of participants who were introduced to complementary foods up to 3 months, up to 4 months, up to 5 months, and greater than 5 months of age. There were no significant differences in body composition for those who were breastfed for any amount of time; however, when certain factors (maternal age, BMI, height, education, social class, smoking in late pregnancy, infant birth weight, and age of introduction of solid foods) were adjusted for, the lean mass was higher in the participants who had been breastfed for longer (40). These findings suggest, breastfeeding not only has a protective effect against overweight and obesity (3,5,18-22), but also on adiposity (39-40).

### **Rationale, Hypotheses, and Specific Aims**

According to NHANES data, there is a high prevalence of childhood overweight and obesity in the United States (1,14), and overweight children are likely to become overweight adults with adverse health problems (1,14). Several studies have shown that breastfeeding has a protective

effect against overweight and obesity in children (4,5,6). Introducing infants to complementary foods before 6 months of age has been shown to produce heavier children with higher adiposity than those introduced later (38,49-52). Studies have also shown that BMI is not accurate in estimating body fat (55), and therefore more accurate measures should be utilized to estimate fat mass. The findings from this research project may be able to highlight the protective effect breastfeeding has on not only overweight and obesity, but also adiposity in children. It may also show if the timing of introduction to complementary foods has an effect on body fat of children. Our working hypothesis is longer breastfeeding duration is associated with lower childhood adiposity. Our first specific aim is to determine the relationship between infant feeding and childhood adiposity in early childhood. It is hypothesized that children who were exclusively breastfed for three months will have a lower overall adiposity compared to children who were mixed-fed because of the protective effects of breast milk. Our second specific aim is to determine the relationship between the age of introduction to complementary foods and childhood adiposity. It is hypothesized that children who were introduced to complementary foods before the age of 6 months will have higher adiposity.

### CHAPTER 3

## ASSOCIATIONS OF EARLY INFANT FEEDING AND ADIPOSITY AMONG SCHOOL- AGED CHILDREN<sup>1</sup>

<sup>1</sup>Whitworth CL, Anderson AK. To be submitted to The Journal of Human Lactation.



**Abstract**

The purpose of this study was to examine the role of infant feeding practices on childhood overweight and obesity. The specific aims were to determine the relationship between 1) infant feeding and childhood adiposity and 2) age of introduction to complementary foods and childhood adiposity. Participants in this cross-sectional study ( $N = 27$ ) were mostly white (66.7%), female (88.9%) and average age was  $4.1 \pm$  years. There was no statistically significant relationship between infant feeding practice and adiposity or between age of introduction to complementary foods and adiposity. There was, however, a significant, positive correlation between the mother's BMI and the birth weight of the child ( $P=.009$ ) and the child's current weight ( $P=.031$ ). More research with adequate power is needed to examine the role of infant feeding and the timing of introduction of complementary foods on body composition in pre-school children to inform effective interventions for obesity prevention.

## **Introduction**

Obesity is a national health concern that continues to create poor health outcomes for both adults and children. Data from the National Health and Nutrition Examination Survey (NHANES) from 1999 to 2010 indicates that 26.7% of pre-school aged children 2 to 5 years of age have BMI-for-age over the 85<sup>th</sup> percentile and 12.1% have BMI-for-age over the 95<sup>th</sup> percentile (1). In a similar report by the Centers for Disease Control and Prevention (CDC), 15.8% of the state of Georgia's 2 to 5 year old children was between the 85<sup>th</sup> and 95<sup>th</sup> BMI percentile-for-age and 13.5% was over the 95<sup>th</sup> BMI percentile-for-age (2). While there are a myriad of factors related to this high prevalence among young children, a lack of breastfeeding, or sub-optimal breastfeeding, has been identified as a potentially major contributing factor to this epidemic (3,4,5,6).

Breastfeeding has been reported to promote leanness in young children (3,4), and longer duration of breastfeeding has been linked to a reduced risk of childhood overweight and obesity (5,6). Infants, who are exclusively breastfed for longer durations, and thus not introduced to complementary foods until 6 months of age or later, have been observed to be leaner than those who are not (38, 49-52). One study showed the early introduction of complementary foods can have adverse effect on a child's weight at 7 years old (49). While there have been many studies reporting breastfeeding's protective effect on childhood overweight and obesity (3,4,5,6), there have been reports that challenge this (12). The reasons for the discrepancies in the literature could be the different methods of measuring and estimating body fat. These inconsistencies (Table 2.1) call for more research to determine if breastfeeding does reduce childhood overweight and obesity. These studies did not use accurate measurements for estimating body fat content, and therefore there is a need for more studies using accurate body composition tests. Because suboptimal breastfeeding is a risk factor for childhood overweight and obesity (4,5,12,20,33,39,40,48) and there have been inconsistencies in the methods of body composition estimation (4-6,12,20,25,33,39-40,48) it is

important to continue to study the associations between infant feeding practices and childhood obesity.

Air-displacement plethysmography (ADP) has been evaluated to be an accurate, easy and convenient way to measure body composition in adults and infants (7,8,9). Up until 2011, children ages 6 months to 5 years could not be measured in BOD POD (COSMED USA) machines, but with the introduction of the pediatric option, there is now a bridge in the previous gap of knowledge (10,11). The BOD POD pediatric option has been reported to be as accurate in measuring the body composition of young children as other traditional body composition methods including dual-energy X-ray absorptiometry and total body water (10, 11).

This research project seeks to examine the relationship between infant feeding type, duration of breastfeeding, and age of introduction to solid foods and adiposity in children ages 4 to 6 years.

## **Methods and Design**

### **Study Design**

This was a cross-sectional study conducted between January 2012 through May 2013 to determine the effects of the type of infant feeding practices and timing of complementary feeding on early childhood adiposity. Mothers aged at least 18 years or older and their children 4 to 6 years, residing in the Athens Area and surrounding communities were recruited to participate in the study.

### *Inclusion and exclusion criteria*

The study included Caucasian and African American males and females between the ages of 4 and 6 years. Older and younger children or children of other ethnicities were not included in this study. The children had to be able to sit in the BOD POD for the allotted time, so they could not have physical disabilities limiting their mobility. The parents had to have a way to get to the University's campus, and they had to stay to fill out the questionnaire.

### *Questionnaire development and testing*

A structured questionnaire of 95 questions was developed to collect information about the child's anthropometrics, infant feeding practices, current dietary habits, and physical activity level as well as the mother's anthropometrics. An extensive literature review was conducted to identify all the pertinent information for a study like this one. Different dietary recall questionnaires were reviewed to identify one that was specific for children. After deliberation, the Harvard School of Public Health and the Brigham and Women's Adolescent Food Frequency Questionnaire (Fields et al 1999) was selected to serve as the base for this project's dietary recall. Age-appropriate foods and eating habits were adopted from this questionnaire for use in this project (see Appendix A). To quantify each participant's diet, a numerical value was placed on each question, and the method of numerical assignment was modeled after the United States Department of Agriculture's Center for Nutrition Policy and Promotion's Healthy Eating Index (58). High numbers were given to answers that reflected a participant frequently ate healthier foods. Low numbers were assigned to answers that reflected a participant frequently ate unhealthy foods. When the numbers were totaled, those with higher scores ( $>300$ ) were considered good diets, and the lower scores ( $\leq 299$ ) were considered poor diets.

Participants who provided their signed written consent were interviewed and child's body composition measured. Based on the interview, mother-child pairs were divided into one of three groups: exclusive breastfeeding (EBF), mixed feeding (MF), or exclusive formula feeding (FF). EBF was defined as giving the infant no water, formula, or any other item except breast milk since the birth of the child. For the purposes of this study, children who received only breast milk as their source of nutrition for the first 4 to 6 months were considered exclusively breastfeeding to align more with breastfeeding recommendations/guidelines (4). MF was defined as given some proportion of breast milk and infant formula for the child's nourishment during early infancy. FF

was defined as having given nothing but infant formula (no breast milk) to the infant since birth.

Because of the small sample size and a few of the formula fed children having received some breast milk in the immediate postpartum period, we decided to combine mixed fed and formula fed into one group for the data analysis and appropriate interpretation of the results from this study.

### *Questionnaire*

The parents were asked how they fed their child as an infant (breastmilk, formula or both) and for how many months. Then they were asked at what age the child was introduced to complementary foods as defined as any food that is not breastmilk, formula, or water. In situations where the child was mixed fed, the parent was asked to estimate the proportion of the child's nutrition from breast milk as an infant. Parents were asked to write down their child's activities in hours per days of the week. They were also self-reported on their own age, height, weight, and age at birth of the child.

### *Recruitment*

Flyers for this study were posted in the Athens area in libraries, recreation buildings, pediatrician's offices, and exercise facilities. Emails with the flyers in an attachment were also sent to pre-schools, day care centers, churches, and elementary schools. Besides the initial flyers and emails, reminders were sent out and flyers redistributed after 6 months to encourage new participants.

When a potential participant contacted the investigator, either by telephone or email, an appointment was made for the parent to bring their child in. Instructions were given for the child to remove all metal before coming to the research laboratory and to wear a bathing suit or similar spandex-like clothing.

### *Consent*

All interested participants (mother-child pairs) reported to the Maternal and Child Nutrition Research Lab, Department of Foods and Nutrition, UGA where they were informed of the study

protocol. Participants who agreed to participate in the study were taken through the consent process after which they had the opportunity to review the informed consent form and provided a written consent by signing the form to be enrolled in the study. The Institutional Review Board of the University of Georgia approved all procedures. All participants received a copy of the signed consent form. Participants were then interviewed for data collection and the child's body composition measurement conducted immediately after. Participants received a hardcopy of the body composition results of the child, and \$25 compensation for their time and participation.

The child's parent or guardian was given two copies of the consent form to read over before the data collection and body composition measurement begun. Parents were informed of the study's purpose and were given a brief description of how the BOD POD testing would proceed. They were given an opportunity to ask questions about the study and the BOD POD, and then they were asked to read over the consent form thoroughly, signed the consent form and proceeded to respond to the questionnaire and BOD POD testing.

#### *BOD POD measurement*

The BOD POD was calibrated as directed by the manufacturer (COSMED Inc., Concord, CA, USA). If the weight scale has not been calibrated in two weeks or moved since last use, the scale was calibrated using standard 20-kilogram weights. After this, the BOD POD was calibrated by measuring the empty chamber with the Pediatric Seat secured in the test chamber, followed by adding the calibration cylinder (19.977 L) according to the manufacturer's protocol. Testing procedures for the body composition measurement were explained to the subject. The child was then asked to change into a one-piece swimsuit. Participant hair was tucked into a bathing cap and all jewelry, if any, was removed. This was done to minimize isothermal effects of the hair and prevent false measurements.

After the child changed into the recommended swimsuit, his/her height was measured via a standing stadiometer to the nearest 0.1 cm. The subject's information consisting of name, date of birth, gender, height and ethnicity was subsequently entered into the computer while the BOD POD goes through a 2-point calibration. First, the volume of the test chamber of the BOD POD was measured with only the Pediatric Seat inside. Then, a 19.977 L calibration cylinder was placed on the Pediatric Seat in the BOD POD with the door closed. After the 2-point calibration, the participant's weight was taken via an electronic weighing scale connected to the BOD POD. The calibration cylinder was removed and subject asked to enter the BOD POD, seated and secured in the Pediatric Seat. The participant was then instructed to sit very still, not to talk or laugh, and to breathe normally. Then the door to the test chamber of the BOD POD was closed for the body volume measurement. A total of 3 body volume measurements are conducted each lasting about 50 seconds with the BOD POD door opened in between measurements. The three body volumes were to be within 0.2% or 150mL between each other. If the 3 body volume measurements were not in the required range, the system requests to repeat the entire test. After successful body volume measurement, the participant was asked to step out of the BOD POD while the computer system used the predicted TGV to estimate the child's body composition. All methods and procedures were reviewed and approved by the University of Georgia's Institutional Review Board.

## **Subjects**

Subjects were children ages 4 to 6 years and at least one parent or guardian. Participants were recruited via emails, flyers, and word of mouth in the Athens, GA area. A total of 27 children participated in the study. Two subjects were fraternal twins, and one subject was adopted.

## **Statistical Analysis**

Statistical analysis was performed using IBM SPSS Statistics 20 (SPSS Inc., Chicago, IL). Descriptive statistics was used to describe participant characteristics with results presented as

frequencies and percentages for categorical variables (eg, gender, race, infant feeding practices, mothers who currently consume alcohol, family diet changes, age of the child, age of the mother, BMI of the mother, and birth weight of the child) and means for continuous variables. Pearson Chi-square test was used to explore the differences between groups (e.g., mixed-fed and formula-fed participants, exclusively breastfed participants) and the mother's BMI and the child's diet. The level of statistical significance was set at  $P < 0.05$ .

## **Results**

### **Characteristics of participants**

Table 3.2 presents the characteristics of the participants and their mothers. Most of the children in the study were female (66.7%) and Caucasian (88.9%). None of the mothers reported smoking or consuming alcohol during pregnancy. Also, none of the mothers reported being current smokers, but about half of the mothers reported currently consuming alcohol. About two-thirds (40.7%) of the children were exclusively breastfed for at least 4 months while 40.7% were mixed and 18.5% were predominantly formula fed. The average age of the children in the study was  $4.89 \pm 0.8$  years; exclusively breastfed  $5.09 \pm 0.34$  years, mixed fed  $4.64 \pm 0.17$  years and formula fed  $5.00 \pm 0.56$  years. Only 11.1% of families reported having changed their child's diet significantly in the past year. Some of the reasons given for dietary change included a recent gluten allergy, family's preference for a whole food diet, and the family becoming Pesceterian. All families reported cooking meals at home.

The participants who were exclusively breastfed ( $3.62 \pm 0.26$  kg) were slightly heavier at birth than their mixed-fed counterparts ( $3.34 \pm 0.54$  kg). The exclusively breastfed participants were also, on average, 2 cm longer than their mixed fed counterparts at birth (Table 3.1). The current weight of the exclusively breastfed participants was slightly less ( $19.22 \pm 2.95$  kg) than their mixed fed counterparts ( $20.14 \pm 3.60$  kg). Conversely, children who were exclusively breastfed were slightly



taller ( $113.99 \pm 9.94$  cm) than the mixed fed counterpart ( $112.23 \pm 8.20$  cm) at the study's measurement. On the average, children who were exclusively breastfed had higher percent body fat compared to those who were mixed fed (Table 3.1). Interestingly, children who were mixed fed were reported to be slightly more active than their exclusively breastfed counterpart (Table 3.1). The exclusively breastfed participants had a better diet quality as indicated by a higher score (300.18) on the Healthy Eating Index compared to the mixed fed participants (298.50).

The mothers of the exclusively breastfed children were older ( $30.45 \pm 5.59$  years) than mothers of mixed fed children ( $27.63 \pm 4.06$  years). Also, mothers who exclusively breastfed their children were heavier than their mixed fed counterparts (Table 3.1).

Findings from the study show that, 29.4% of normal weight mothers exclusively breastfed their children for 4-6 months during infancy, compared to 66.7% of overweight and 57.2% of obese mothers who exclusively breastfed their children for that same period of time. Also 41.2% of normal weight mothers mixed fed, while 43.3% of overweight and 42.9% of obese mothers did. Surprisingly, no overweight or obese mothers exclusively formula fed their infants (Figure 1).

Children who were introduced to solid foods before the age of 4 months although weighed less, had more percent body fat than those who were introduced 4 months of age or later (Figure 3.2).

## **Correlations**

There was a significant, positive correlation between the mother's BMI and the birth weight of the child ( $P=.009$ ), and the child's current weight ( $P=.031$ ). There was not, however, a significant correlation between mothers BMI and any of the child's body composition indicators, nor was there a significant relationship with mother's current age or age at the child's birth. There was a positive correlation between the age of introduction to complementary feeding and the child's current weight

( $P=.313$ ), percent body fat ( $P=.488$ ), and fat mass in kilograms ( $P=.437$ ), but none of these correlations were statistically significant.

## **Discussion**

Childhood overweight and obesity have a negative impact on a child's health and are often accompanied by co-morbidities (1,13-15,41). While there is no solitary solution to this health epidemic, breastfeeding has been reported to decrease the risk of childhood overweight and obesity (3,5,18-22,48). Also, the longer duration of exclusive breastfeeding, and subsequent later introduction of complementary foods, has also been shown to reduce childhood overweight and obesity (6, 21, 24-27,38,46,48,49-52). There have been studies that show no associations between breastfeeding and lower rates of overweight and obesity (7), and this could be because of the variations in the instruments and methods of testing for overweight and obesity. Therefore, it is important to understand the true relationship between breastfeeding and childhood overweight and obesity and adiposity. This research project sought to decipher the link between breastfeeding and childhood adiposity through the use of air-displacement plethysmography (ADP). To the best of our knowledge, this is the first study to examine breastfeeding, age of introduction to complementary foods and childhood adiposity using the BOD POD Pediatric Option.

Findings from this study show that children who were mixed fed weighed more and were shorter than the exclusively breastfed children. Despite being shorter and heavier, the mixed fed group had lower percent body fat and less fat mass in kilograms. Toschke et al (2007) found that those breastfed for 6 months or more had lower fat mass in kilograms (as measured by a DXA machine) compared to those who had never been breastfed ( $P<0.001$ ). Also, those who had never been breastfed had higher BMI than those who had been breastfed for 3-5 months and 6 months or more (39). In addition, Bogen et al (2004) found that children breastfed for at least 8 weeks had a lower prevalence of obesity compared to a group that either breastfed for less than 8 weeks or

formula fed only (11.7% vs. 10.2%,  $p < 0.001$ ). Also, children who were exclusively breastfed had a lower prevalence of obesity than those who were mixed fed (5). In contrast, this research study found that participants who were exclusively breastfed had higher fat mass in kilograms and had a greater total weight in kilograms. Participants who were introduced to complementary foods at or after 4 months (and therefore were breastfed longer) weighed more than their peers who were introduced to complementary foods earlier.

Robinson et al (2009) found that 4-year-old children who had been breastfed for 12 months or more had a lower fat mass than those who were not breastfed for that time period (40). However, Burdette et al (2006) did not find a significant relationship between those who were exclusively breastfed and those never breastfed and their fat mass (38). This research project also did not find a significant relationship between infant feeding practice and the child's fat mass. The findings did suggest that those who were exclusively breastfed had a slightly higher fat mass than their formula fed counterparts.

The age of introduction to complementary foods also has an impact on a child's health status (38, 49-52). Table 3.3 and Figure 3.1 summarize the finding of the timing of complementary foods in this study. Children who were introduced to complementary foods 4 months of age or later weighed more than those who were introduced before 4 months. Those introduced later also had a slightly lower average percent body fat and lower body fat mass than those introduced earlier. Vafa et al (2012) found that 7-year-old children who were introduced to complementary foods 6 months of age or later weighed less than those who were introduced earlier (49), which contradicts findings from the current study. Interestingly, Burdette et al (2006) did not find a significant relationship between children introduced to complementary foods before or after 4 months of age and fat mass (38). These inconsistencies from previous and current studies may be due to other biological and environmental factors not examined in the studies.

This study's findings show that there is a significant correlation between a mother's BMI and her child's current weight. This finding is in agreement with those reported by Hediger et al (2001) using data from NHANES. In their study the authors observed the incidence of a child being overweight nearly tripled with his or her maternal overweight BMI status (4). These findings demonstrate how influential maternal weight status may be over a child's weight and body composition confirming both biological and environmental dimensions of childhood obesity.

There were several limitations in the study design and data collection that may limit the generalizability of the results. First, the participants were largely from highly educated families connected to the University Of Georgia. While education level may not directly affect infant feeding practices, educated families are more likely to participate in healthy activities and practices. The participants were also fairly homogenous; most of them were Caucasian and female, which is not a good representation of the population. Secondly, there were only 27 participants in the study, and larger numbers could have produced more statistically significant associations or observations. In the questionnaire given to the parents, several important questions were left out, that in retrospect, could have provided a better understanding of the participants nutrition and health behaviors. The parents were not asked if their children were born term or preterm, which could have affected their body composition. Also, they were not asked about any problems during their pregnancy. Gestational diabetes, pregnancy-induced hypertension, and early labor could have had an effect on the child's size and weight. Lastly, parents were not asked if their children were taking any medications that could have affected their body composition such as Ritalin or Prednisone.

Overall, these findings do not suggest that breastfeeding or age of introduction to complementary foods has a significant, protective effect on childhood adiposity. In addition, it seems that exclusive breastfeeding and later introduction to complementary foods increase a child's body fat mass and body fat percentage. Further research is needed to ascertain if these findings are

still true in larger and more diverse population. The findings from this study show that a mother's overweight or obese status has a greater impact on her child's weight than her chosen infant feeding practices. Further examination of these phenomena will hopefully give a better understanding of childhood overweight and obesity.

**Table 2.1** Variations in Infant Feeding and Body Composition Measurements

<b>Author</b>	<b>Study Design</b>	<b>Age at Measurement</b>	<b>Infant Feeding Method Definition (if applicable)</b>	<b>Measurement</b>
Bergmann et al 2007 (3)	Longitudinal birth cohort	6 years	Breastfed for less than 3 months or bottle-fed were considered bottle-fed. Breastfed for 3 months or more were considered breastfed	BMI-for-age percentiles and skin-fold thickness
Hediger et al 2001 (4)	Retrospective cohort study	3 to 5 years	Fully breastfed (no liquids daily other than breast milk or water). Partially breastfed (supplemented daily with formula or milk)	BMI-for-age percentiles
Bogen et al 2004 (5)	Retrospective cohort study	4 years	Breastfed for $\geq 8$ weeks considered exclusively breastfed	BMI
Fields and Goran 2000 (29)	Cross- sectional	10 to 12 years	N/A	Hydrostatic weighing, ADP, deuterium dilution, DXA
Fields and Allison 2012 (31)	Cross-sectional	2 to 6 years	N/A	ADP, DXA, deuterium dilution
Nicholson et al 2001 (32)	Cross-sectional	8 to 11 years	N/A	ADP
Wells et al 2003 (36)	Cross-sectional	5 to 7 years	N/A	ADP, deuterium dilution, BMI
Burdette et al 2006 (38)	Cross-sectional	5 years	Exclusively breastfed defined as nothing but breastmilk, mixed-fed given formula and breastmilk, and formula-fed never given breastmilk	DXA
Toschke et al 2007 (39)	Prospective cohort	9 to 10 years	Exclusively breastfed defined as nothing but breastmilk	BMI and DXA
Robinson et al 2009 (40)	Prospective cohort	4 years	Exclusively breastfed defined as nothing but breastmilk	BMI and DXA
Forsum et al 2013 (55)	Cross-sectional	4 years	N/A	BMI and ADP

**Table 3.1** Differences in Exclusive Breastfeeding and Mixed Feeding

	Exclusive Breastfeeding Mean $\pm$ SD	Mixed Feeding Mean $\pm$ SD
Birth weight (kg)	3.62 $\pm$ 0.26	3.34 $\pm$ 0.54
Birth length (cm)	52.96 $\pm$ 2.20	50.09 $\pm$ 2.57
Current weight of child (kg)	19.22 $\pm$ 2.95	20.14 $\pm$ 3.60
Current height of child (cm)	113.99 $\pm$ 9.94	112.23 $\pm$ 8.20
Body fat (%)	17.29 $\pm$ 6.97	14.51 $\pm$ 5.67
Fat free mass (%)	82.71 $\pm$ 6.97	85.49 $\pm$ 5.67
Fat mass (kg)	3.66 $\pm$ 1.91	2.90 $\pm$ 1.22
Lean mass (kg)	17.28 $\pm$ 4.50	17.24 $\pm$ 3.36
Total physical activity in hours per week	19.05 $\pm$ 5.42	19.72 $\pm$ 12.69
Maternal age at birth of child (yr)	30.45 $\pm$ 5.59	27.63 $\pm$ 4.06
Maternal current age	35.73 $\pm$ 6.28	32.63 $\pm$ 3.88
Maternal weight (kg)	78.73 $\pm$ 23.99	67.76 $\pm$ 13.43
Maternal height (m)	1.70 $\pm$ 0.08	1.66 $\pm$ 0.06
Maternal BMI (kg/m <sup>2</sup> )	26.98 $\pm$ 7.32	24.58 $\pm$ 4.92

**Table 3.2** Summary of Participants

	<b>n (%)</b>
Gender	
Female	18 (66.7)
Male	9 (33.3)
Race	
White	24 (88.9)
African American	3 (11.1)
Consume Alcohol Currently	
Yes	11 (40.7)
No	16 (59.3)
Infant Feeding Practice	
Breastfed Exclusively	11 (40.7)
Breastfed and Formula Fed	11 (40.7)
Formula Fed	5 (18.5)
Family Diet Change	
Yes	3 (11.1)
No	24 (88.9)
	<b>Mean <math>\pm</math> SD</b>
Age of Child	4.89 $\pm$ 0.80
Birth Weight in Kilograms	3.46 $\pm$ 0.46
Birth Length in Centimeters	51.26 $\pm$ 2.78
Current weight in Kilograms	19.76 $\pm$ 3.32

Current height in Centimeters	112.95 $\pm$ 8.81
Percent Body Fat	15.64 $\pm$ 6.26
Percent Fat Free Mass	84.36 $\pm$ 6.26
Fat Mass in Kilograms	3.21 $\pm$ 1.55
Fat Free Mass in Kilograms	17.26 $\pm$ 3.78
Maternal Weight in Kilograms	72.07 $\pm$ 18.80
Maternal Height in Centimeters	163.22 $\pm$ 14.66
Maternal Age	33.89 $\pm$ 5.12
Maternal Age at Birth of Child	28.78 $\pm$ 4.85
Exclusively Breastfed in Months	5.20 $\pm$ 3.06
Formula Fed in Months	1.40 $\pm$ 3.15
Days Per Week Eat at Home	6.40 $\pm$ 0.76
Days Per Week Fast Food Eaten	0.96 $\pm$ 0.75
Total Activity in Hours Per Week	19.44 $\pm$ 10.21
Healthy Eating Index	299.19 $\pm$ 17.68

**Table 3.3** Age of Introduction to Complementary Foods

	Introduced to Complementary Foods < 4 Months Mean $\pm$ SD	Introduced to Complementary Foods $\geq$ 4 Months Mean $\pm$ SD
Weight of Child in Kilograms	18.12 $\pm$ 2.40	20.23 $\pm$ 3.44
Percent Body Fat	15.82 $\pm$ 5.77	15.60 $\pm$ 6.53
Percent Fat Free Mass	84.18 $\pm$ 5.77	84.40 $\pm$ 6.53
Fat Mass in Kilograms	3.43 $\pm$ 2.08	3.14 $\pm$ 1.42
Fat Free Mass in Kilograms	17.71 $\pm$ 5.62	17.13 $\pm$ 3.26

**Table 3.4** Percent of Infant Feeding Practice by Maternal BMI Category

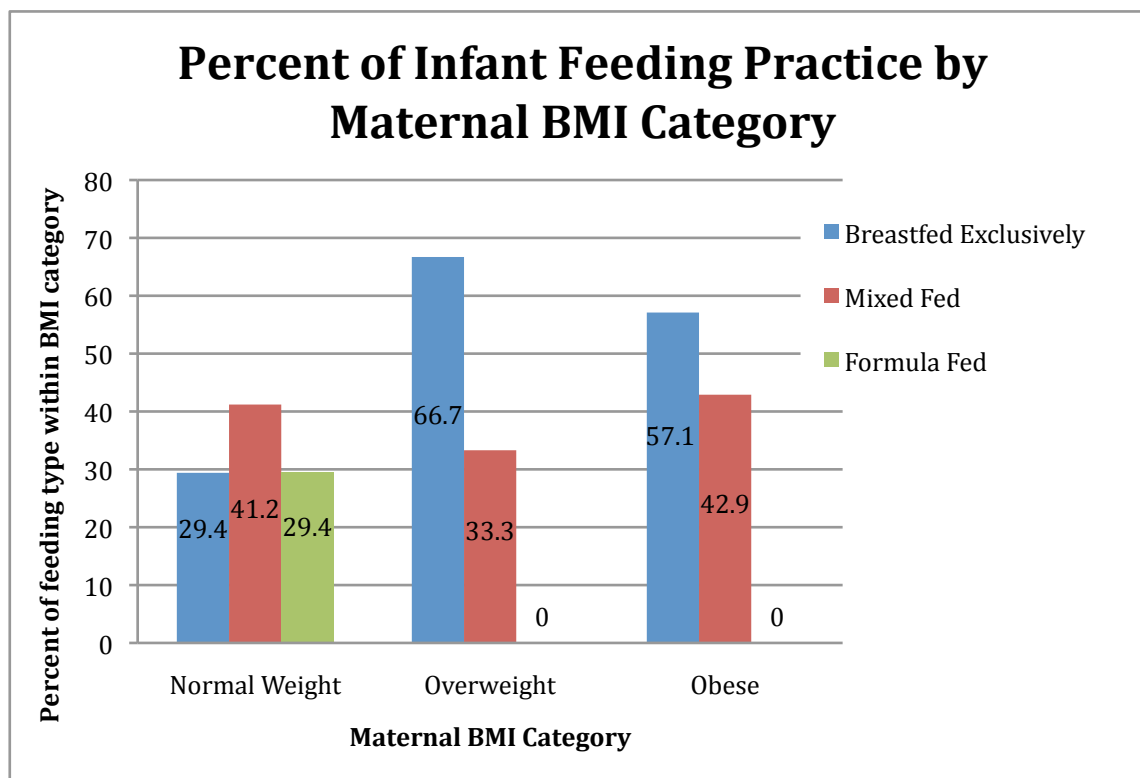
	Normal Weight n=17(%)	Overweight n=3 (%)	Obese n=7 (%)
Breastfed Exclusively	29.4	66.7	57.1
Mixed Fed	41.2	33.3	42.9
Formula Fed	29.4	0.0	0.0

**Table 3.6** Percent of Maternal BMI Category by Infant Feeding Practice

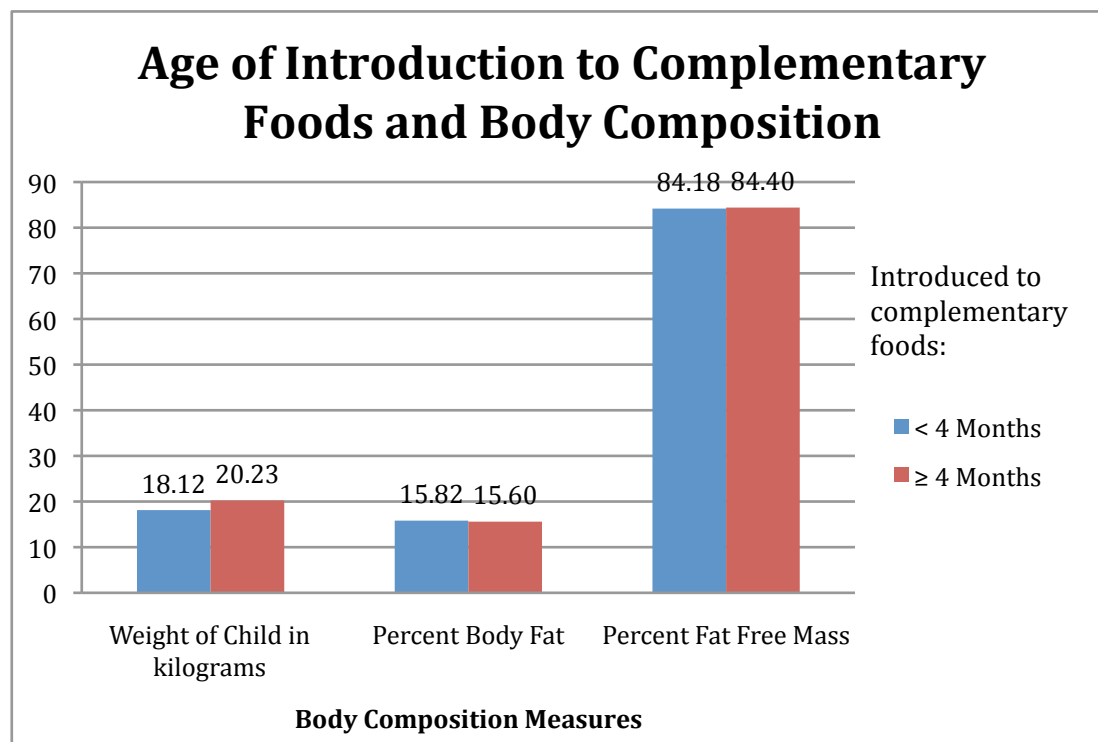
	Normal Weight (%)	Overweight (%)	Obese (%)
Breastfed Exclusively	45.5	18.2	36.4
Mixed Fed	63.6	9.1	27.3
Formula Fed	100	0.0	0.0



**Figure 3.1** Infant Feeding Practice by Maternal BMI Category



**Figure 3.2** Age of Introduction to Complementary Foods and Body Composition



## CHAPTER 4

### CONCLUSION

The results from this study do not suggest that there is a protective effect against childhood overweight and obesity from exclusive breastfeeding, which is a confirmation to findings by Burdette et al (38). Indeed, the results indicate that exclusively breastfed children have higher percent body fat and fat mass around ages 4 to 6 years. While these results are not congruent with results from other studies (3,5,18-22,48), they are also not statistically significant.

This study demonstrated that there is a link between the age of introduction to complementary foods and childhood overweight and obesity. The results show that children introduced to complementary foods earlier had higher body fat mass and percent body fat compared to those introduced to complementary foods 4 months or later. Although these results are not statistically significant, but they are congruent with the results from Vafa et al (2012) (49).

There are a myriad of contributing factors to childhood obesity, and infant feeding practices have significant relationships with childhood body composition (3,5,18-22). Few studies have used ADP to measure body composition (10,11,29,30-37) and infant feeding practices, and even fewer have used the BOD POD Pediatric Option to measure body composition (10). The reliability and validity of this instrument makes its use as a body composition measurement tool invaluable in future research of childhood body composition. Future research should use this ADP machine to measure childhood body composition across the lifespan to see if the infant feeding practice's effect on body composition in childhood carries into adulthood. Also, larger and more diverse populations should be studied to see if these results are valid in larger groups. This could provide insight into

how infant feeding practices affect body composition not only in childhood, but also throughout the lifespan.

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## APPENDICES

APPENDIX A  
QUESTIONNAIRE

**Childhood Adiposity Associated with Estimates of Breast Milk Intake, Duration and Infant Feeding Practices**

Date: \_\_\_\_\_

**Child's Health History:**

Age: \_\_\_\_\_

Birth weight: \_\_\_\_\_

Birth length: \_\_\_\_\_

Current weight: \_\_\_\_\_

Current height: \_\_\_\_\_

**Office Use Only:**

Fat Mass	
Fat-Free Mass	
Percent Body Fat	

**Maternal History:**

Weight: \_\_\_\_\_

Height: \_\_\_\_\_

Age: \_\_\_\_\_

Age at child's birth: \_\_\_\_\_

1. Did you smoke cigarettes during pregnancy?    Yes    No
  - a. If yes, how often? \_\_\_\_\_
2. Do you currently smoke cigarettes?    Yes    No
  - a. If yes, how often? \_\_\_\_\_
3. Did you consume alcohol during pregnancy?    Yes    No
  - a. If yes, how often? \_\_\_\_\_
  - b. What type? (circle all that apply)    Wine    Beer    Liquor
4. Do you currently consume alcohol?    Yes    No
  - a. If yes, how often? \_\_\_\_\_
  - b. What type? (circle all that apply)    Wine    Beer    Liquor

**Infant Feeding History:**

1. How was your child fed as an infant?

Breastfed exclusively

Breastfed and formula-fed

Formula-fed

2. If breastfed exclusively, for how long? \_\_\_\_\_

a. At what age did you start introducing solid foods or semi-solid foods? \_\_\_\_\_

3. If breast and formula-feed your child, what proportion of the infant's nutrition came from breastmilk? \_\_\_\_\_

a. At what age did you start introducing solid or semi-solid foods? \_\_\_\_\_

\_\_\_\_\_

4. If exclusively formula-fed, what type/brand of infant formula did you use? \_\_\_\_\_

a. At what age did you start introducing solid or semi-solid foods? \_\_\_\_\_

5. How long was your child fed any breastmilk? \_\_\_\_\_

### Dietary Habits:

1. Has your family's or child's diet changed drastically in the past 2-3 years? (Have you become vegetarian? Switched to low-fat eating?) Yes No

a. If yes, please describe:

\_\_\_\_\_  
 \_\_\_\_\_

2. Do you cook meals at home? Yes No

a. How many days per week? \_\_\_\_\_

3. How many days per week does your child eat fast food? \_\_\_\_\_

### Physical Activity:

1. Please list all of the physical activities that your child participates in and how often he/she participates. (Walking, playing, swimming, riding bicycles, ect.)

Activity	Hours per day	Days per week

2. How would you describe your child's activity level?

- a. Sedentary
- b. Low-active
- c. Moderately active
- d. Active
- e. High active

**MEALS:**

3. Where does your child usually eat breakfast?

- A. At home
- B. At school
- C. Doesn't eat breakfast
- D. Don't know

4. How many times each week (including weekends and weekdays) does your child usually eat breakfast prepared away from home?

- A. Never or almost never
- B. 1-2 times per week
- C. 3-4 times per week
- D. 5 or more times per week

5. How many times each week (including weekends and weekdays) does your child usually eat lunch prepared away from home?

- A. Never or almost never
- B. 1-2 times per week
- C. 3-4 times per week
- D. 5 or more times per week

6. How many times each week (including weekends and weekdays) does your child usually eat dinner prepared away from home?

- A. Never or almost never
- B. 1-2 times per week
- C. 3-4 times per week
- D. 5 or more times per week

7. How often does your child have dinner that is ready-made, like frozen dinners, boxed macaroni and cheese, Spaghetti-O's, ect?

- A. Never or almost never
- B. 1-2 times per week
- C. 3-4 times per week
- D. 5 or more times per week

**BEVERAGES:**

8. How often does your child drink soda-not diet (1 can or glass)

- A. Never/less than 1 per month
- B 1-3 cans per month
- C. 1 can per week
- D. 2-6 cans per week
- E. 1 can per day
- F. 2 or more cans per day

9. How often does your child drink fruit drinks (not fruit juices) like lemonade, Hawaiian Punch, Kool-Aid, or other non-carbonated fruit drinks?

- A. Never/less than 1 per month
- B 1-3 glasses per month
- C. 1 glass per week
- D. 2-6 glasses per week
- E. 1 glasses per day
- F. 2 or more glasses per day

10. How often does your child drink sweetened ice tea?

- A. Never/less than 1 per month
- B 1-3 glasses per month
- C. 1 glass per week
- D. 2-6 glasses per week
- E. 1 glasses per day
- F. 2 or more glasses per day

11. How often does your child drink white milk?

- A. Never/less than 1 per month
- B 1-3 glasses per month
- C. 1 glass per week
- D. 2-6 glasses per week
- E. 1 glasses per day
- F. 2 or more glasses per day

12. How often does your child drink flavored milk (like strawberry or chocolate)?

- A. Never/less than 1 per month
- B. 1-3 glasses per month
- C. 1 glass per week
- D. 2-6 glasses per week
- E. 1 glasses per day
- F. 2 or more glasses per day

13. What TYPE of milk (white or flavored) does your child drink?

- A. Skim/nonfat
- B. 1% or low-fat
- C. 2%
- D. Whole

14. How often does your child drink milk alternatives (almond, rice, soy)?

- A. Never/less than 1 per month
- B. 1-3 glasses per month
- C. 1 glass per week
- D. 2-6 glasses per week
- E. 1 glasses per day
- F. 2 or more glasses per day

15. How often does your child drink fruit juices? (grape, apple, orange, ect)

- A. Never/less than 1 per month
- B. 1-3 glasses per month
- C. 1 glass per week
- D. 2-6 glasses per week
- E. 1 glasses per day
- F. 2 or more glasses per day

16. Does your child drink 100% juice or no sugar added juice?

- A. Yes
- B. No
- C. Don't know

## **FRUITS & VEGETABLES:**

17. How often does your child eat dried fruit?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

18. How often does your child eat canned fruit? (applesauce, mandarin oranges, fruit cocktail)

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

19. How often does your child eat fresh fruit? (apple slices, bananas, cantaloupe, ect)

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

20. How often does your child eat cooked vegetables? (collard greens, green beans, sweet potatoes, ect)

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

21. How often does your child eat raw vegetables? (carrot sticks, broccoli, tomatoes, ect)

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

#### **DAIRY/MILK PRODUCTS:**

22. How often does your child eat yogurt? (not frozen)

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

23. How often does your child eat cottage or ricotta cheese?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

24. How often does your child eat cheese?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

25. How often does your child eat butter or margarine?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

#### **BREADS & CEREALS:**

26. How often does your child eat cold breakfast cereal?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

27. How often does your child eat hot breakfast cereal (like oatmeal, grits, ect)?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

28. How often does your child eat white breads (sliced bread, pita, rolls)?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day



29. How often does your child eat wheat breads?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

30. How often does your child eat muffins?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

31. How often does your child eat rice?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

32. How often does your child eat pasta/noodles?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

33. How often does your child eat French fries?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

### **MAIN DISHES:**

34. How often does your child eat cheeseburgers or hamburgers?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

35. How often does your child eat pizza?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

36. How often does your child eat chicken nuggets?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

37. How often does your child eat tacos/burritos/nachos?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

38. Which taco filling does your child typically have? (circle all that apply)

- A. Beef
- B. Beans
- C. Chicken
- D. Cheese

39. How often does your child eat hot dogs?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

40. How often does your child eat chicken or turkey sandwiches?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

41. How often does your child eat roast beef or ham sandwiches?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

42. How often does your child eat salami or bologna sandwiches?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

43. How often does your child eat grilled cheese sandwiches?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

44. How often does your child eat chicken or turkey as a main dish?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

45. How often does your child eat fish sticks, fish cakes, or fish sandwiches?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

46. How often does your child eat fresh fish as a main dish?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

47. How often does your child eat beef (steak, roast, ect) as a main dish?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

48. How often does your child eat pork or ham as a main dish?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

49. How often does your child eat lasagna/baked ziti?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

50. How often does your child eat macaroni and cheese?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

51. How often does your child eat spaghetti with tomato sauce?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

52. How often does your child eat spaghetti with alfredo sauce?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

53. How often does your child eat eggs?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

54. How often does your child eat shrimp, lobster, or other shellfish?
- A. Never/less than once per month
  - B. 1-3 times per month
  - C. 1 time per week
  - D. 2-6 times per week
  - E. Once per day
  - F. 2 or more times per day

**SNACK FOODS/DESSERTS:**

55. How often does your child eat regular potato chips?
- A. Never/less than once per month
  - B. 1-3 times per month
  - C. 1 time per week
  - D. 2-6 times per week
  - E. Once per day
  - F. 2 or more times per day

56. How often does your child eat baked potato chips?
- A. Never/less than once per month
  - B. 1-3 times per month
  - C. 1 time per week
  - D. 2-6 times per week
  - E. Once per day
  - F. 2 or more times per day

57. How often does your child eat corn chips?
- A. Never/less than once per month
  - B. 1-3 times per month
  - C. 1 time per week
  - D. 2-6 times per week
  - E. Once per day
  - F. 2 or more times per day

58. How often does your child eat popcorn?
- A. Never/less than once per month
  - B. 1-3 times per month
  - C. 1 time per week
  - D. 2-6 times per week
  - E. Once per day
  - F. 2 or more times per day

59. How often does your child eat pretzels?
- A. Never/less than once per month
  - B. 1-3 times per month
  - C. 1 time per week
  - D. 2-6 times per week
  - E. Once per day
  - F. 2 or more times per day

60. How often does your child eat fruit gummies or fruit rollups?
- A. Never/less than once per month
  - B. 1-3 times per month
  - C. 1 time per week
  - D. 2-6 times per week
  - E. Once per day
  - F. 2 or more times per day

61. How often does your child eat crackers (saltines, club)?
- A. Never/less than once per month
  - B. 1-3 times per month
  - C. 1 time per week
  - D. 2-6 times per week
  - E. Once per day
  - F. 2 or more times per day

62. How often does your child eat pop-tarts or pastry toasters?
- A. Never/less than once per month
  - B. 1-3 times per month
  - C. 1 time per week
  - D. 2-6 times per week
  - E. Once per day
  - F. 2 or more times per day
63. How often does your child eat cookies?
- A. Never/less than once per month
  - B. 1-3 times per month
  - C. 1 time per week
  - D. 2-6 times per week
  - E. Once per day
  - F. 2 or more times per day
64. How often does your child eat cake?
- A. Never/less than once per month
  - B. 1-3 times per month
  - C. 1 time per week
  - D. 2-6 times per week
  - E. Once per day
  - F. 2 or more times per day
65. How often does your child eat ice cream?
- A. Never/less than once per month
  - B. 1-3 times per month
  - C. 1 time per week
  - D. 2-6 times per week
  - E. Once per day
  - F. 2 or more times per day
66. How often does your child eat brownies?
- A. Never/less than once per month
  - B. 1-3 times per month
  - C. 1 time per week
  - D. 2-6 times per week
  - E. Once per day
  - F. 2 or more times per day
67. How often does your child eat pie?
- A. Never/less than once per month
  - B. 1-3 times per month
  - C. 1 time per week
  - D. 2-6 times per week
  - E. Once per day
  - F. 2 or more times per day
68. How often does your child eat snack cakes (like twinkies, oatmeal cream pies)?
- A. Never/less than once per month
  - B. 1-3 times per month
  - C. 1 time per week
  - D. 2-6 times per week
  - E. Once per day
  - F. 2 or more times per day
69. How often does your child eat doughnuts?
- A. Never/less than once per month
  - B. 1-3 times per month
  - C. 1 time per week
  - D. 2-6 times per week
  - E. Once per day
  - F. 2 or more times per day
70. How often does your child eat chocolate bars? (Hershey's, M&M's, ect)
- A. Never/less than once per month
  - B. 1-3 times per month
  - C. 1 time per week
  - D. 2-6 times per week

- E. Once per day
- F. 2 or more times per day

71. How often does your child eat candy without chocolate (skittles, sour patch kids, ect)?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

72. How often does your child eat pudding or pudding snack packs?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

73. How often does your child eat/drink milkshakes?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day

74. How often does your child eat popsicles?

- A. Never/less than once per month
- B. 1-3 times per month
- C. 1 time per week
- D. 2-6 times per week
- E. Once per day
- F. 2 or more times per day