EXCLUSIVE BREASTFEEDING DURATION IN RELATION TO INFANT RISK FOR OVERWEIGHT AND OBESITY AT THREE YEARS OF AGE

by

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DEDICATION

To Joe, your love has no equal. To Dad, your quiet, steadfast support proved extremely effective. And to Mom, I wish you were here.

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Colleagues, family, and friends made the past five years a transformational experience. Drs. Claire M. Fagin and Patricia G. Archbold launched me on my way and sent regular waves of encouragement. Rachael Watman, along with esteemed BAGNC colleagues, offered pearls of insight that translated across our respective professional fields. Under the wise and patient mentorship of Drs. Kathleen Gaffney and Panagiota Kitsantas, I learned the art and science of research as well as an abiding respect for its role in health care. As work progressed, Dr. Charlene Douglas provided keen insight that sharpened the focus of this study. Debby Kermer guided the conversion of a formidable mass of raw numbers into a well-organized data set. As I look back on our weekly consultation sessions, I realize she asked most of the questions, and expected me to discover the answers. It was a challenging, effective, and method of instruction. I also discovered a sustaining force within my doctoral cohort. Dr. Kristin Caulfield and Suzy Fehr proved expert study and writing partners, which evolved into friendships that will last longer than the time we spent huddled over statistical problems and dissertation drafts.

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Friends served as my rudder, helping me hold a good line amid real and perceived obstacles. Thank you Andi, Ann, Anna, Debbie, Ed, Eve, Krista, Mimi, Pam, Sheliah, Wanda, and the entire C.B.C. family, my next goal is to repay in kind.

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LIST OF ABBREVIATIONS

Body Mass Index .... BMI
Centers for Disease Control and Prevention .... CDC
Institute for Health Metrics and Evaluation .... IHME
National Health and Nutrition Examination Survey .... NHANES
National Institutes for Health .... NIH
Pediatric Nutrition Surveillance System .... PedNSS
Prenatal Nutrition Surveillance System .... PNSS
Research Portfolio Online Reporting Tools .... (RePORT)
Special Supplementary Nutrition Program for Women, Infants, & Children .... WIC
United States .... U.S.
World Health Organization .... WHO

ABSTRACT

EXCLUSIVE BREASTFEEDING DURATION IN RELATIONSHIP TO INFANT RISK FOR OVERWEIGHT AND OBESITY UP TO THREE YEARS OF AGE.

Patricia D. Franklin, Ph.D.

George Mason University, 2013

Chair: Dr. Kathleen F. Gaffney

This non-experimental, quantitative study examined exclusive breastfeeding during the first six months of life as a risk reduction factor of childhood overweight and obesity up to three years of age in a population of children who participated in a state Special Supplementary Nutrition Program for Women, Infants, and Children (WIC). A literature review described the salient issues involved in childhood obesity, examined the conflicting results in determining the association between breastfeeding and a risk of developing childhood obesity, and supported the need for further study in at-risk populations. The pediatric nutrition surveillance system (PedNSS) offered access to linked, longitudinal data with which to explore this relationship within a sample of children at risk for early childhood obesity. The results of this research project indicated that the longer an infant exclusively breastfeeds, the lower their risk for overweight/obesity at three years of age regardless of other contributing factors. Results

also indicated pre-gestational, gestational, and early childhood mechanisms are areas for interdisciplinary research to develop effective, preventative strategies and policies.

CHAPTER ONE: INTRODUCTION TO STUDY

While the rapid, upward trajectory of obesity in the United States (U.S.) began slowing in 2003, Finkelstein et al. (2012) recently projected a 33% increase in the prevalence of obesity in the adult population (> 18 years of age) over the next two decades, along with a 130% increase in severe obesity. The results of their study indicated that by 2030, obesity would affect 51% of the U.S. adult population. This statistic also takes into account the current generation of children—because children born in 2012 will be 18 years old in 2030. Therefore, health care practitioners need evidence-based strategies and policies to improve the odds that children in the U.S. will enjoy a healthy life course, unencumbered by the adverse consequences of obesity.

Childhood obesity in the U.S. increased dramatically over the past three decades, doubling among children two to five years of age and tripling among those six to 11 years old. Further, children from minority and low-income families developed obesity at higher rates compared to the general U.S. pediatric population (Singh, Kogan, & van Dyck, 2008; Singh, Siahpush, Hiatt, & Timsina, 2011; Singh, Siahpush, & Kogan, 2010; Wang, 2011). What's more, these populations are increasing in the U.S. The 2010 U.S. Census reported a significant increase among minority child populations, in which Hispanics represent the largest, absolute increase (U.S. Census Bureau, 2011).

In response to the observed epidemic-like pattern of U.S. childhood obesity, scientific investigations sought to understand its etiology, identify effective treatments, and ultimately develop prevention strategies. Between 2000 and 2010, published articles on obesity tripled in the *Archives of Pediatric and Adolescent Medicine* (Whitaker, 2011). Using the search term “childhood obesity,” a query submitted to the National Institutes of Health (NIH) Research Portfolio Online Reporting Tools (RePORT) program revealed a similar surge in NIH-funded research in childhood obesity (http://report.nih.gov/).

According to the RePORT search results, NIH funded 336 projects focused on or related to childhood obesity between fiscal years 1989 through 1999. During the next decade (2000–2010), NIH increased the number of such projects by almost 90% (N = 3023). Another 1,040 obesity-related proposals received NIH funding for fiscal years 2011 to 2013 (NIH, 2012).

The existing literature described childhood obesity as a complex health problem influenced by genetic, epigenetic, physiological, psychological, social, and economic mechanisms. Various factors and forces that occur along the life span may increase the risk for childhood obesity. Some of these factors, such as a high maternal prepregnancy body mass index (BMI), exist in the preconception period (Olson, Demment, Carling, & Strawderman, 2010).

Obesity exposes a child to both immediate and long-term health risks. Short-term health problems include reduced exercise tolerance, fatigue, social isolation, and poor academic achievement. The literature also identified obesity as a significant risk for developing long-term health problems, which may be compounded by the timing at which obesity develops and the length of time an individual remains obese (Cruz et al., 2005; Daniels, 2006; Slining, Adair, Goldman, Borja, & Bentley, 2010; Stocks et al., 2011).

Physiological and psychosocial changes observed in obese children are also associated with early-onset chronic diseases previously seen primarily in adult populations. These include sleep disturbance, cardiovascular changes, elevated serum cholesterol, high blood pressure, insulin resistance, and type 2 diabetes (Baker et al., 2005; Freedman, Mei, Srinivasan, Berenson, & Dietz, 2007; Labarthe, Dai, Day, Fulton, & Gunbaum, 2009). The literature also reveals an emergent focus on the impact of obesity in infants and toddlers. The results of a study (N = 217) by Slining et al. (2010) revealed motor delay was 1.80, 95% CI [1.09 -2.97] times as likely to occur in overweight infants when compared to normal-weight infants.

Whitaker, Wright, Pepe, Seidel, and Dietz (1997) published one of the first reports on the risk of an obese child remaining obese throughout his or her life. In this study (N = 854) results indicated that obesity in older children was an important predictor of adult obesity. The odds ratio for adult obesity associated with obesity at 15 to 17 years of age, after adjusting for parental obesity, was 17.5, 95% CI [7.7 – 39.5]. In another study, which used a sub-set of children (N = 555) from a multi-site research project, the calculated odds ratio suggested similar risks. The analysis revealed that a child who was overweight (BMI > 85%) during preschool or elementary school was more than five times ($p < .05$) as likely to be overweight at age 12 as those children measured at < 85% for BMI (Nader et al., 2006). Kitsantas and Gaffney (2010) also examined potential risk profiles of overweight and obesity in children (N= 6700) who participated in the Early Childhood Longitudinal Study-Birth Cohort (ECLS-B). Preschool children in the ECLS-B study who were overweight or obese at two years of age were four times more likely ($p < 0.00$) to be overweight and obese by the time they were four years old.

Examining these trends in further detail, Lee et al. (2010) analyzed the trajectories of obesity over the life course for the U.S. population. They found that recent cohorts of individuals (e.g. those born between 1976 and 1985) reached a higher prevalence of obesity earlier in their life course, compared with cohorts born between 1956 and 1965. Jolliffe (2004) observed not only that more children were overweight than in previous decades, but also that overweight children were heavier than in previous cohorts. The authors also pointed out that developing obesity at an earlier age predisposes an individual to the risk of prolonged obesity. This observation implies that an obese child is at greater risk of remaining obese and that prolonged obesity may impose additional immediate and long-term health issues.

Nutrition represents a fundamental cornerstone to children's health. Years of scientific research established breastfeeding and breast milk as a preferred source of nutrition for infants and babies. In 2011, the U.S. Surgeon General issued a call to action to support breastfeeding, endorsing breastfeeding as the best nutrition for infants (U.S. Department of Health and Human Services, 2011). Science continues to discover breast milk's positive effect on infant physiology (Chapkin et al., 2010).

However, studies examining effects of breastfeeding on the risk for childhood obesity offer conflicting results. A review of the literature revealed the differences in definitions and metrics for obesity and overweight, plus small and homogenous samples are significant issues that confound and limit the interpretation of these studies (Arenz, Ruckerl, Koletzko, & von Kries, 2004; Ip et al., 2007). Further, few intervention studies involved subjects younger than two years of age, and fewer consider breastfeeding as a major independent variable (Ciampa et al., 2010).

Statement of problem

Obesity represents a genuine threat to a child's short-term and long-term health. Breathing problems, exercise intolerance, and social isolation manifest early, compared to high blood pressure, type II diabetes, and cardiovascular disease that become symptomatic after significant, permanent changes develop (Baker et al., 2005; Cruz et al., 2005; Daniels, 2006). The resulting chronic disease states not only increase the risk for a diminished quality of life, but also may also potentially shorten life expectancy. While an extensive body of research describes many features of obesity, the myriad facets of obesity also confound attempts to identify mutable factors that reduce the risk for obesity.

Variations in terms, definitions, study populations, designs, metrics, and tools impede development of robust evidence that informs practice (Ogden & Flegal, 2010). Studies examining the association between breastfeeding and a reduced risk of childhood obesity report inconsistent and conflicting results (Butte, 2009; Harder, Bergmann, Kallischnigg, & Plagemann, 2005; Ip et al., 2007; Monasta et al., 2010; Procter & Holcomb, 2008).

Studies used common terms such as *overweight* and *obese* for outcome variables. However, definitions and measures for these variables differed significantly. For example, Procter and Holcomb (2008) defined overweight as a calculated BMI-for-age of $\geq$ 95%, whereas Taveras et al. (2011) used the same BMI value ($\geq$ 95%) to define obesity. Definitions for breastfeeding also varied among studies or they were never explicitly described. Twells and Newhook (2010) described exclusive breastfeeding as feedings of only breast milk and no formula, juice, or water for up to and including three months of age. Missing from their definition is whether they excluded or included breast milk fed by a bottle. Another study defined exclusive breastfeeding as breastfeeding for the first four weeks of life, excluding consumption of water and/or medications (Goldfield et al., 2006). The authors excluded medications and water, yet did not mention inclusion or exclusion of juice or breast milk fed by bottle. Metzger and McDade (2010) cite the lack of distinguishing language in the survey used to collect data as a limitation of their secondary data analysis study. Their study, the Panel Study of Income Dynamics (PSID), and the corresponding Child Development Supplement (DCS) survey did not distinguish between infants exclusively breastfed, infants receiving other foods while breastfed, or the use of breast pumps.

Another issue in the reported literature is the design method. A majority of studies measured the effect of breastfeeding on the risk of obesity by comparing outcomes between ever-breastfed infants and never-breastfed infants. Few studies compared the effect of exclusive breastfeeding with other types of breastfeeding to determine if a dose-related effect exists. This resulted in a gap of understanding whether children exclusively breastfed for one month experience the same reduction in the risk of obesity as infants exclusively breastfed for two months, or three months, or longer.

Would infants who were exclusively breastfed experience the same reduction in the risk of obesity as infants who were not exclusively breastfed?

A literature search using the term “exclusive breastfeeding and obesity” resulted in five studies that examined the relationship of exclusive breastfeeding to childhood obesity. Broadening the search to “breastfeeding and obesity” resulted in 17 studies that investigated the impact of breastfeeding on the risk of obesity in children. In one study, Weyermann, Rothenbacher, and Brenner (2006) examined the association between the duration of breastfeeding and childhood overweight at the age of two years in a sample of German children. Specifically, they conducted statistical analysis to determine if a difference exists between children exclusively breastfed for at least six months compared to children who were exclusively breastfed for less than three months. A more detailed review follows in Chapter 2. However, the limited results of the literature search underscore the paucity of evidence available.

Meta-analyses conducted in the past decade noted design issues, as well. Cross-sectional studies may be used to study a phenomena’s effect over time; however, they are problematic and produce results that lack the credibility of longitudinal studies (Polit & Beck, 2012). Few longitudinal studies have examined the effect of breastfeeding on the risk for childhood overweight and obesity and differing statistical analyses obscure existing evidence (Arenz, Ruckerl, Koletzko, & von Kries, 2004; Harder, Bergmann, Kallischnigg, & Plagemann, 2005; Owen et al., 2005). For example, according to Beyerlein, Toschke, and von Kries (2008), research studies that investigated the protective effects of breastfeeding on risk for overweight using linear regression reported no significant association, whereas study designs that used logistic regression reported a protective effect.

With an estimated annual cost of $147 billion to manage and treat consequences of obesity, policy makers need evidence that informs program development, as well as decisions in allocation of limited resources (Finkelstein, Trogdon, Cohen, & Dietz, 2009). In other words, health care practitioners need evidence-based practice standards, programs, and resources with which to screen, prevent, and treat childhood obesity. The imperative to reduce the incidence and health risks of childhood obesity exists; however, the evidence remains elusive.

Background of the study

At approximately the same time that obesity rates in the U.S. adult population began climbing, the Centers for Disease Control and Prevention (CDC) tracked a similarly dramatic change in the incidence and prevalence of childhood obesity. The acceleration in obesity rates of children between two and five years of age appeared to lag behind the acceleration seen in school-age children and adolescents by approximately 10 years (Ogden & Carroll, 2010). To understand the scope of childhood obesity, a review of the natural history of adult obesity provided important background information.

Adult obesity. Trends and features of obesity and associated health risks in the U.S. adults are well documented in the literature. The overall U.S. adult obesity rates remained relatively stable between 1960 and 1976 (Flegal, 1996). During that time, approximately 13% of adults in the U.S. met the obesity definition of a body mass index (BMI) value ≥ 30. However, over the ensuing three decades, CDC tracked and reported an epidemic-like rise in the prevalence of adult obesity and overweight (CDC, 2011a). By 2006, the overall age-adjusted prevalence of obesity in the U.S. adult population was 33.8% (Flegal, Carroll, Ogden, & Curtin, 2010).

In 2010, Flegal et al. used the National Health and Nutrition Examination Survey (NHANES) data from 2003 through 2008 to continue the study of adult obesity trends. They reported that over two-thirds of the adult population were either overweight (BMI ≥ 25) or obese (BMI ≥ 30) (Flegal et al., 2010). In addition, Ogden and Carroll (2010) reported that the prevalence of extreme adult obesity (BMI ≥ 40) increased in a similar pattern as obesity rates. In the same year, CDC reported state-by-state adult obesity rates, which ranged from a low of 18.6% in Colorado to a high of 34.4% in Mississippi. Only Colorado and the District of Columbia had a prevalence rate < 20%, while nine states reported a prevalence ≥ 30% (Sherry et al., 2010).

More recently, Flegal, Carroll, Kit, and Ogden (2012) released the results of the latest NHANES data, which were collected between 1999 and 2010. The authors reported no significant change in the prevalence of obesity in the adult population between 2003 and 2008. Although these results are encouraging, there was no indication of a reverse trend in the prevalence of obesity, which forecasts a future with considerable risk for long-term health problems. This is consistent with other findings. As mentioned previously, Finkelstein et al. (2012) projected an unprecedented level of obesity and severe obesity in the U.S. adult population that underscores health risks facing the U.S. adults.

Both short- and long-term health effects of obesity are reported in the literature. Using data from the third NHANES data set, Olshansky et al. (2005) calculated the impact of obesity on life expectancy. Their results indicated that if obesity trends persist, future generations are at a risk for a shorter life expectancy compared to current generations. A study by the Institute for Health Metrics and Evaluation (IHME) at the University of Washington reported that between 2000 and 2007, U.S. life expectancy began to fall significantly behind other developed countries (Kulkarni, Levin-Rector, Ezzati, & Murray, 2011). While other countries demonstrated continued gains in life expectancy, U.S. data revealed a decline in computed life expectancy. Although the study did not identify a particular cause for the observed trend, the authors proposed the increased prevalence in obesity as one of the four major contributing factors to the deceleration in U.S. life expectancy.

Childhood obesity. Ogden and Carroll (2010) reported results of a study that examined trends in childhood obesity over a 45-year period. Their study utilized NHANES data from 1963-2008. In the publication, a line graph representing trends in U.S. childhood obesity (see fig.1) revealed differences between three age groups of children. The acceleration in obesity rates of children between two and five years of age appeared to lag behind the acceleration seen in school-age children and adolescent groups by approximately 10 years. Specifically, Ogden and Carroll (2010) found that obesity doubled among children two to five years of age yet tripled among those six to 11 years old during those three decades. By 2007, an estimated 10.58 million children 10 to 17 years of age were overweight or obese (Bethell, Simpson, Stumbo, Carle, & Gombojav, 2010).

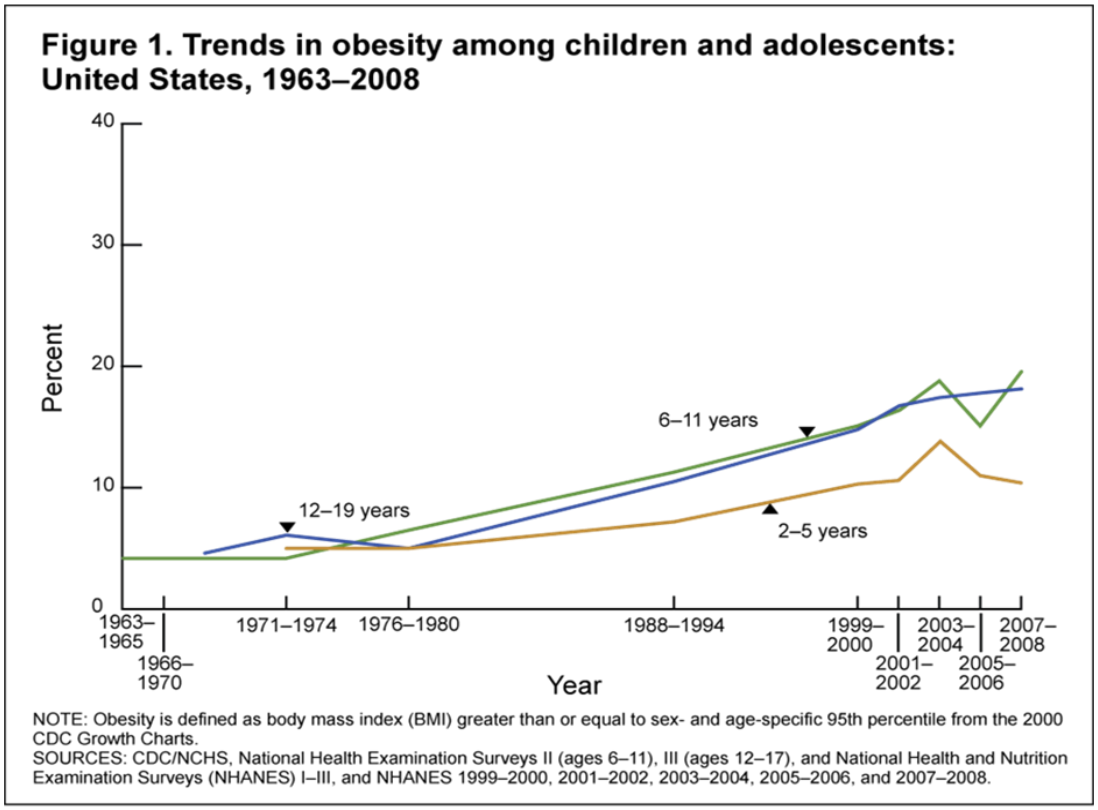

Figure 1. Trends in U.S. childhood obesity, 1963–2008.

CDC also tracked and analyzed obesity trends in lower-income children five years of age and younger through a state-based Pediatric Nutritional Surveillance System (PedNSS). Using the PedNSS data set, Sharma et al. (2009) from the Division of Nutrition, Physical Activity and Obesity, National Center for Chronic Disease Prevention and Health Promotion at CDC, reported trends of childhood obesity observed in this particular population between 1998 and 2008. During that decade, PedNSS data was collected solely by each state's Special Supplemental Nutrition Program for Women, Infants and Children (WIC), except in California and North Carolina. Sharma et al. (2009) defined obesity for children age two to four, as a BMI-for-age > 95th percentile, based on the 2000 CDC sex-specific growth charts. Chapter 2 provides details of the PedNSS program and measurement standards. However, for the purposes of this section, the trends observed between 1998 and 2008 in their PedNSS sample are discussed.

Sharma et al. (2009) reported a rapid increase (0.43% annually) in the overall prevalence of childhood obesity between 1998 and 2003. Over the next five years, the overall prevalence of obesity slowed to a 0.02% annual rate. By 2008, obesity was highest among American Indian/Alaskan Native (21.2%) and Hispanic (18.5%) children, and lowest among non-Hispanic white (12.6%), Asian/Pacific Islander (12.3%), and non-Hispanic black (11.8%) children (Sharma et al., 2009).

Within the past few years, several significant developments in health care provided standards relevant to practice and research. CDC recommended a universal adoption of the 2006 World Health Organization (WHO) international growth-monitoring standards for children less than 24 months of age (CDC, 2010a). These standards differ significantly from previous growth charts in that they were developed using the growth of the breastfed infant as the norm. CDC also issued standard terminology defining overweight and obesity (Ogden & Flegal, 2010). These recommendations afford an opportunity to conduct and compare research that considers early life factors that either increase or reduce the risk for childhood overweight and obesity.

In 2010, the National Center for Health Statistics issued a report by an expert committee announcing changes in the metrics and terms for measuring and reporting childhood obesity (Ogden & Flegal, 2010). The expert committee reinforced the assumption that while body mass index (BMI) for age is an indirect measurement of obesity, it remained the recommended measurement standard. Further, measurements of BMI for age and sex between the 85th and 95th percentile that previously described children (two to 20 years old) as ‘‘at risk for overweight,’’ would now describe children as “overweight.” Additionally, a calculated BMI for age and sex at or above the 95th percentile (formerly a reference for ‘‘overweight’’) would describe children as “obese.” With these new metrics and terms, Ogden, Carroll, Kit, and Flegal (2012) reported that between 2009 and 2010, almost 17% of all children and adolescents met the criteria for obesity.

Purpose of the study

The purpose of this secondary data analysis study is to examine exclusive breastfeeding during the first six months of infancy as a potential risk reduction factor of childhood overweight and obesity up to three years of age in a Kansas WIC population, using the PedNSS data set. Therefore, a longitudinal prospective design is appropriate to answer the following research questions:

1. What associations exist between observed risk factors in the study sample and overweight/obesity at three years of age?
2. What is the association between different durations of exclusive breastfeed and overweight and obesity at three years of age?

3. Do infants that are exclusively breastfed for different lengths of time have different risks for overweight and obesity at three years of age after adjusting for maternal education level?

4. Do infants who are exclusively breastfed for different lengths of time have different risk for overweight/obesity at three years of age when other contributing factors exist?

Theoretical framework

Identifying early preventive mechanisms, including risk reduction factors, may reduce risk for obesity. The Life Course Health Development model (LCHD) provides a framework within which to study these relationships. LCHD, an integrated theoretical framework with multidisciplinary roots, is increasingly used for health care and policy research. Grounded in social, behavioral, and human development science, the LCHD model provides a robust and relevant research paradigm (Elder, 1994; Elder, 1998: Halfon and Hochstein (2002) published a comprehensive discussion of LCHD's four core principles, their interrelated nature, and the process by which biological and environmental factors shape one's health development throughout the life cycle.

According to the LCHD model, the interaction of external forces and internal human attributes, especially at sensitive and/or critical times along the life course, account for variation in the trajectories of health development. Further, the model assumes that early life events are capable of producing both positive and negative long-term effects on one's health trajectory. Thus, chronic disorders experienced later in life may be linked to early life exposures and interactions of certain forces at sensitive and critical periods.

Halfon, DuPlessis, and Inkelas (2007) described a significant change in the nature of primary pediatrics over the past 30 years. They characterized a shift from a practice predominantly focused on acute, episodic events to a practice that deals with a larger proportion of chronic disorders. In their analysis, current pediatric health care providers reported a preponderance of chronic disorders such as obesity, learning and developmental disabilities, and mental health problems. Therefore, the authors suggested a need for transforming the current child health care model. They proposed strategic steps toward building a model focused on prevention and health development. This model would result in effective services that will ultimately improve children's health.

Healthy life trajectories begin with a solid foundation that has footings in genetic, epigenetic, prenatal, neonatal, and early childhood history. An optimal health trajectory is dependent on a cumulative source of protective factors throughout life (Halfon & Hochstein, 2002). Conversely, poor health trajectories result from cumulative adverse events and conditions that weaken the foundation and limit future development. The compounding effect of subsequent adverse events, and/or reduction in future protective factors, may significantly modify a child's health trajectory. One recommendation, therefore, is to focus resources on prevention and early interventions that minimize adverse risks and enhance protective factors.

Wise (2009) wrote a critical review of the life-course model and underscored areas of its potential weakness and limitations, especially when LCHD is applied to the study of health disparities. The author used examples of research in which members of a population experience similar adverse events early in life, such as abuse or poor intra-uterine nutrition. According to Wise, a review of the literature revealed that the varied responses to adverse events are dependent on the degree of the adverse event, the individual's genetic attributes, the timing of the adverse event, as well as the social and political environment in which the adverse event occurs. Further, the author noted that subsequent life experiences, their timing, their dose, and the context within which they occur influence one's life course in a range of patterns and to a varying degree, which renders the predictive value of early life events' impact on later years strikingly low.

Wise also cautioned that assigning a deterministic character to the life-course model might lead to misguided research and ineffectual policies. Rather, the author contended that life events and their resulting effects are far more malleable than often conceptualized in research studies that utilize a life-course theoretical framework. Equally, the resulting impact of adverse events on an individual's health trajectory is potentially responsive to interventions along the entire life continuum. Based on this perspective, then, research should focus on the underlying mechanisms of life-course interactions and employ comparative effectiveness studies, which determine levels of response to interventions at different times along the life course.

This perspective is consistent with the results of a large prospective study in which mothers provided a breastfeeding history for their female children whose weight was measured at five, eight, and 18 years of age (Michels et al., 2007). The data analysis revealed that children who were exclusively breastfed were more likely to have a leaner body shape at the age of five, when compared to those who were not breastfed–or who were breastfed for less than one week. However, this association did not persist throughout childhood or at any point later in life.

Halfon, DuPlessis, and Inkelas (2007) presented a compelling case for utilizing the life-course model in their proposed strategies for reforming the U.S. child health system. Based on empirical evidence demonstrating that adverse early-life events place children at risk for developing health problems later in life, the authors drew logical connections to the value of prevention. They proposed that preventing these exposures decreases a child's risk for later problems. Therefore, prevention and interventions at early stages of life should be the focus of health policy initiatives.

In Halfon and Hochstein's (2002) thorough account of the LCHD framework, the final section focused on implications for future research. The authors called for longitudinal studies that begin at or before conception to capture the neuroendocrine status of the mother. Further, they urged that data should be collected during those development transition periods where changes in function, as well as interaction with the environment, occur.

For the purposes of this study, the LCHD theoretical framework provided a coherent method for identifying and enhancing risk-reducing and health-promoting factors that support an individual's health trajectory (see fig. 2). Exclusive breastfeeding may offer additional health protective factors that significantly mitigate the effects of other risks occurring during and within a certain period after breastfeeding ceased. An infant who received optimum nutrition and gained age- and gender-appropriate weight during the first six months of life may have experienced a reduced risk of overweight and obesity during the first few years of life. Further, during the period when the effect of exclusive breastfeeding persisted, certain measures that reinforce age-appropriate nutritional, physical, and social behaviors would reinforce that early foundation. Ultimately, each developmental period would strengthen the foundation for the next stage, resulting in an optimal health trajectory for life.

A healthy start may not offer protection from significant adverse events in the future; however, in combination with continued health promoting and risk-reduction behaviors, a healthy start may contribute to the potential for a healthier life trajectory. Figure 2 demonstrates an adapted version of a model published by Halfon, Inkelas, and Hochstein (2002), modified with permission for the purposes of this paper. The two trajectory lines represent the optimal and suboptimal life-course health development. For the purposes of this study, exclusive breastfeeding represents one health protective factor, which may exert a risk-reduction effect on the life-course trajectory within the first few years of life.

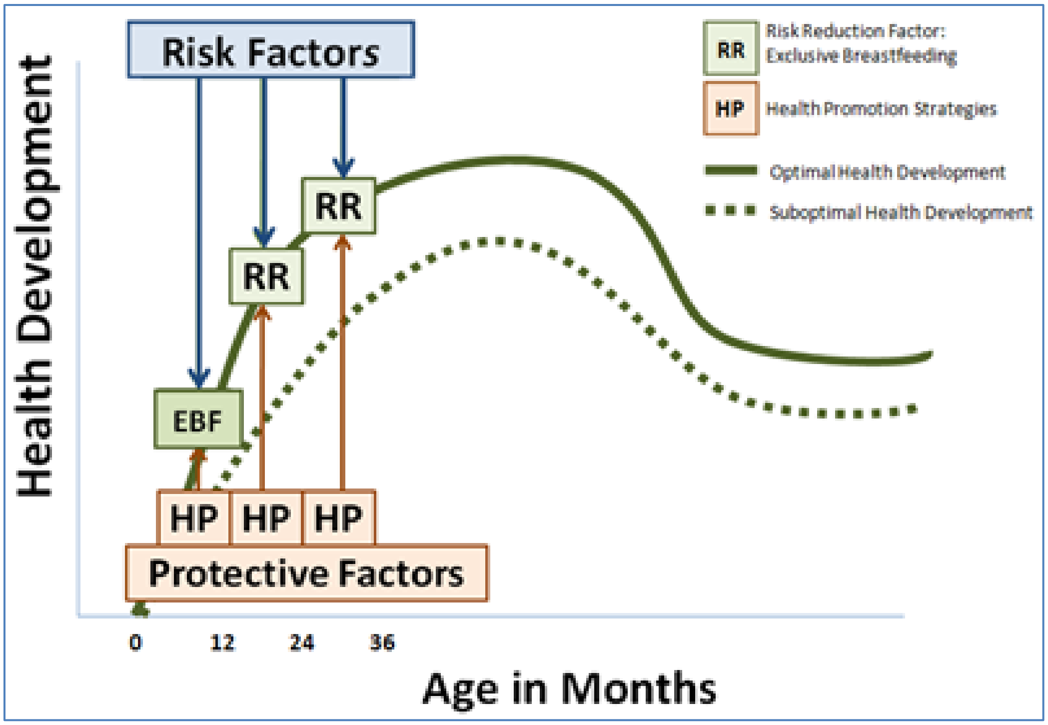

Figure 2. Life Course Health Development Model; Modified with permission from Neal Halfon, JD, MPH

In addition to the previously mentioned research design issues, the measurement of the outcome variable (BMI, weight, or body shape) occurred at various points along removed from exposure to breastfeeding. Measurements occurred from three to 42 years of age (Burdette & Whittaker, 2007; Butte, 2009; Beyerlein, Toschke, & von Kries, 2008; Huus, Ludvigsson, Enskar, & Ludvigsson, 2008; Kramer et al, 2001; Metzger & McDade, 2010; Procter & Holcomb, 2008; Schack-Nielsen, Sorensen, Mortensen, & Michaelsen, 2009; Twells & Newhook, 2010). Children are exposed to a number of additional risks during their lifetime that may obscure any early effect of breastfeeding. Further, the notion that breastfeeding may permanently impart life-long protection is not supported by the literature and defies logic.

For the purposes of this study, the LCHD theoretical model represented a life-long process of identifying and enhancing risk-reducing and health-promoting factors that support an individual's optimal health trajectory. Exclusive breastfeeding represented a health protective factor that mitigated the effects of other risks occurring during the first three years of life. Further, the study proposed that infants who received optimum nutrition and gained appropriate weight for their age and gender experience a reduced risk of overweight and obesity during early childhood. Combined with other measures to continue optimal nutritional, physical, and social behaviors, exclusive breastfeeding was considered a potential risk-reduction factor for childhood overweight and obesity.

Definition of terms

Research has provided conflicting results on the effect of risk factors and risk-reduction factors for childhood overweight and obesity in part due to the variations in definitions, arbitrary cut-offs, and various homogeneous reference populations. Added to the lack of standardized terminology and definitions is the fact that no single clinical tool accurately measures obesity. BMI is considered a relatively blunt instrument of measurement since it only considers the relationship between height and weight, but not adiposity (Toschke, Kurth, & von Kries, 2008).

In 2005, the American Medical Association (AMA), in collaboration with CDC and the Health Resources and Services Administration (HRSA), convened an expert committee panel representing 15 national health care organizations. The committee conducted a review on the state of the science in the prevention, assessment, and treatment of childhood overweight and obesity. CDC adopted the expert committee's recommended definitions, which are now used as a standard of measurement practice in the U.S. The committee established that BMI served as the standard measurement with which to screen for overweight and obesity. Further, the committee defined overweight as a BMI at or above the 85th percentile and lower than the 95th percentile for children of the same age and sex, while obesity was defined as a BMI at or above the 95th percentile for children of the same age and sex (Barlow & Expert Committee, 2007). These definitions are in reference to the 2000 CDC growth charts for gender and age, and they apply only to children two years of age and older.

In 2006, WHO issued new growth standards (compared to growth charts) for children 0 to 59 months. An international sample of infants and children followed between 1997 and 2003 constituted the reference population for these standards. Different from growth charts, these standards described the growth of healthy children in optimal conditions. Growth standards are defined by weight for age, length (or stature) for age, weight for length (or stature), and BMI for age. Of interest to this study, these standards are based on infants who were breastfed for 12 months and "predominantly breastfed" for four months (CDC, 2010a, p. 3).

Four years later, CDC issued recommendations for tracking growth of infants and children. For children from birth to 24 months of age, CDC recommended the 2006 WHO growth standards, whereas for children two years of age and older, the 2000 CDC growth charts remained the standard reference. The 2006 WHO growth standards provided an improved tool for tracking a child's growth and established new cut-offs that indicated nutritional risk. The cut-off values of 2.3rd and 97.7th percentiles (or ± two standard deviations) on the 2006 WHO growth standard chart identify the boundaries of normal growth. Any value beyond these two cut-off values indicates a child at nutritional risk. However, the 5th and 95th percentiles remained the standard cut-off values used with the 2000 CDC growth charts (CDC, 2010a).

CDC reported data on Kansas WIC cases from birth to two years of age using the 2006 WHO growth standards. Therefore, for the purposes of this study, anthropometric data on children ≤ two years old reflect these new standards. The data set also includes height (cm), weight (kg), BMI z-scores, and BMI percentiles generated in reference to the 2000 CDC pediatric growth charts for children two years and older. The clinically oriented and practical application of BMI-for –age percentiles were used as measures of overweight and obesity in the study by Procter and Holcomb (2008) as well as Sharma, Cogswell and Li (2008). Therefore, this study used the same metric and the definition as explicated by the Pediatric Nutritional Surveillance System for.

Tables 1 and 2 include conceptual and operational definitions for the outcome and independent variables, with their respective field (operational) definitions as published in the 2004 PedNSS User's Guide, the 2010 PedNSS Non-Unique and Unique Child Master File Record Specifications, and the 2004 Pregnancy Nutrition Surveillance System Field Definitions, Codes, and Edits.

Table 1. Conceptual and operational definitions of outcome variables

Variable	Conceptual	Operational	Reference
Obesity	Obesity is defined as a BMI % at 2 and 3 years of age, that represents a health risk for the child.	Using CDC growth charts, a BMI % at or above the 95th percentile for children of the same age and sex.	Barlow S. E. & Expert Committee, 2007.
Overweight	Overweight is defined as a BMI % at 2 and 3 years of age, that represents a risk for obesity and health risk for the child.	Using CDC growth charts, a BMI % at or above the 85th percentile and below the 95th percentile for children of the same age and sex.	Barlow S. E. & Expert Committee, 2007.

Table 2. Operational definitions of independent variables

Variable	Operational definition
Maternal demographics	
Age	Completed years at time of child's birth
Education	Number of grades completed
Ethnicity/Race	Ethnicity: Hispanic/Latino Race: American Indian Asian Black/African American Native Hawaiian White
Health history factors	
Prepregnancy BMI	Calculated by reported prepregnancy weight and measured height (weight in kilograms/height in meters squared).

Table 2 (cont.)

Variable	Operational definition
Health behavior factors	
Smoking history	Calculated using reported history of cigarettes smoked per day 3 months prior to pregnancy, at first prenatal visit, in last 3 months of pregnancy, and postpartum visit. Coded “Yes” = has smoking history or “No” = no smoking history.
Prenatal care initiation	Trimester medical care began: 1 to 3; no care; and unknown
Child	
Sex	Gender of child recorded as male or female
Health history factors	
Birth weight	Reported and recorded to nearest whole gram or converted from English measurement to grams
Gestational age	Gestational age of infant in days (difference between date of last menstrual period and infant’s date of birth) recoded into weeks and categorized into three groups; less than 37 weeks; 37 to 40 weeks; greater than 40 weeks.
History ever breastfed	Asks if child ever breastfed. Reported and edited for children <24 months of age who are not currently breastfed. 1 = Yes 2 = No 9 = Unknown or not applicable; infant is currently breastfed

Table 2 (cont.)	
Variable	**Operational Definition**
Exclusive breastfeeding	An infant's consumption of human milk with no supplementation of any type (including infant formula, cow's milk, juice, sugar water, baby food and anything else, even water) except for vitamins, minerals, and medications. It is calculated using responses from the introduction to supplementary feeding data item that reports the week of age at which the first supplementary feeding started.
Health behavior factors	
Age supplementary feeding introduced	Week of age first supplementary feeding started. Reported for children < 24 months of age who were ever breastfed. 00–30 = Age in weeks at introduction 31 = 31+ weeks 77 = Not fed anything other than breast milk 99 = Unknown or not applicable; child never breastfed
Anthropometrics	
BMI percentiles	Based on 2000 CDC growth chart percentiles for age and gender.

Significance of the study

This study examined the effect of exclusive breastfeeding on the risk of developing obesity in three-year-old children participating in the Kansas Special Supplementary Nutrition Program for Women, Infants, and Children (WIC). The results of this study inform the literature on potential risk-reduction factors for obesity in at-risk children participating in the Kansas WIC program. The data were collected within the past five years, providing a strong temporal relationship to current issues.

The cause of obesity is not solely the function of consuming more energy than expended, although this remains a fundamental component. Numerous forces that contribute to obesity along the life course represent enormous challenges when examining and identifying mutable mechanisms responsive to evidence-based practices and policies. Therefore, investigating early life mechanisms that may reduce risk for childhood obesity may also translate into reducing the risk for adult obesity, and ultimately reduce the incidence of some chronic illnesses.

The Institute of Medicine (IOM) of the National Academies published recommendations, which strengthens the significance of this study (IOM, 2011). Of particular relevance is the recommendation to plot infant and child weight and length using the WHO growth standard charts (ages 0−23 months) and the CDC growth charts (ages 24−59 months). In addition, it was recommended to recognize a child's weight-for-length or BMI ≥ 85th percentile, rate of weight gain, and parental weight status as risk factors in assessing the risk of obesity and its adverse consequences (IOM, 2011).

There are significant economic consequences to obesity. The estimated annual cost to manage and treat associated consequences of obesity recently approached $147 billion (Finkelstein et al., 2009). As the mounting U.S. debt imposes limits on resources, the imperative to identify both the risks for developing childhood obesity and the factors that reduce the risks takes on added urgency. In fact, Finkelstein et al. (2009) proposed that real cost savings would come from reducing risk factors, as well as reducing obesity.

Primary care pediatric providers need evidence-based practice guidelines for screening and identifying infants and young children at risk for overweight and obesity, as well as evidence-based prevention strategies. Using appropriate standards and references to track growth, employing standardized definitions and values, along with promoting evidence-based risk-reducing factors may mitigate effects of adverse events encountered within a defined life interval. Exclusive breastfeeding may afford significant risk-reduction effect for infants and young children exposed to a high number of obesity risk factors.

Professional and public agencies advocate prevention as a core strategy for reducing childhood obesity. The American Association of Pediatrics (AAP), the National Association of Pediatric Nurse Practitioners (NAPNAP), and IOM publish policies to guide practice and research (Barlow, 2007; NAPNAP, 2009; IOM, 2011). Nutrition, which is universally recognized as a fundamental basis for health and reducing risk of certain diseases, remains a core prevention strategy for health care practitioners. It is also an essential feature in government programs such as WIC, which is designed to ensure and improve the health and well-being of children.

In 2011, over half (2,102,760) of U.S. infants participated in WIC. Health care practitioners, as well as WIC programs that provide services, represent a valuable resource for this population. The Kansas PedNSS database receives all of its data from WIC programs and therefore offers a significant sample of pediatric population with a known increased risk of obesity. Practitioners and providers who care for these families need evidence to guide their practice and services.

Limitations of the study

Doolan and Froelicher (2009) and Boslaugh (2007) detailed limitations inherent in a secondary data analysis study. These limitations may be moderated by methodical planning, which will be discussed later. One primary issue, which limits this study, is the fact the PedNSS and PNSS survey design and data collection predated this study. Both surveillance systems were designed to monitor the nutritional status of low-income infants, children, and women in federally funded maternal and child health programs. Therefore, these data were gathered from a circumscribed population, limiting the generalization of all results (CDC, 2011b). Further, participation in the surveillance program is voluntary, which imposed a level of bias, as well as precluded a random representative sample of this population.

The methods for surveying participants were planned and executed prior to this study, which further limits the design, questions, and analysis. Data collection and measurement procedures occurred at numerous sites without any direct oversight of the faithfulness with which these procedures were conducted, the standardization of the measurement tools, or the training of those collecting data. Finally, the data represent past observations; therefore, changes that occurred since data collection, imposed additional limitations when interpreting results. The review of literature in Chapter 2 addresses these issues in detail.

Magee, Lee, Giuliano, and Munro (2006) identify methodological issues that may threaten validity, reliability, and generalizability of secondary data analyses. First, the study's theoretical framework must demonstrate significant relevance to the original purpose of the database. The preceding section links the LCHD theoretical framework to the primary purpose of the PedNSS and PNSS surveillance programs, as well as the rationale for selecting these databases. A strong conceptual association between the database's purpose and theoretical framework reduces chances of errors in the measurement of relevant variables. Further, the emphasis on prevailing contextual factors in the LCHD model is relevant to the independent variables of this study (i.e., maternal socio-demographic and health history factors). Combined, addressing these three elements significantly strengthens the study design.

Summary

Obesity threatens both the short-term and the long-term health of children. Mounting evidence indicates that the longer a child remains obese, the more likely he or she will be obese as an adult. Further, obesity-associated chronic disease states (e.g. type 2 diabetes) that develop in childhood increase the risk of long-term health consequences and potentially lead to a shorter life expectancy. Minority children in low-income families appear at a greater risk for developing obesity compared to the general child population. Therefore, identifying and promoting evidence-based risk-reduction factors for specific points along the life course of this population may reduce the risk of overweight and obesity. If exclusive breastfeeding represents a risk-reduction factor within this population, practitioners and programs have evidence with which to guide their practice and services.

The primary purpose of this secondary data analysis study is to examine the effect of exclusive breastfeeding on the risk of overweight and obesity in a sample of children participating in the Kansas-state WIC program. A review of literature supported the proposed research questions. The LCHD theoretical framework focused the study's design, methods, as well as interpretation of results.

This dissertation is divided into five sections. Chapter One outlines the salient issues of childhood obesity and provides background information, which supports the proposed research study. Chapter Two examines the state of the science through a review of literature relevant to contributing factors. Chapter Three details the research design and methodology employed for data collection and analysis. Chapter Four describes the characteristics of the analytic sample and presents data analysis results. Finally, the implications of the results are discussed in Chapter Five, with recommendations for future investigation.

CHAPTER TWO: REVIEW OF LITERATURE

The review of literature focused on salient features of this study. The chapter begins with literature that explored exclusive breastfeeding (independent variable) in relation to obesity and overweight and addressed issues concerning the definition of breastfeeding, as well as the measurement of the effect of breastfeeding on overweight and obesity. Next, the review examined body mass index (BMI) as the dependent variable and its use to screen for childhood overweight and obesity. Additional variables, the literature identified as associated with childhood overweight and obesity, are also discussed. These variables include maternal health and health behaviors, socio-economic factors, as well as infant/child factors. Further, studies that reported issues germane to measurement of each variable are reviewed, before finishing with a critical analysis of research related to the Life Course Health Development (LCHD) theoretical framework.

Three major databases--CINAHL, Medline, and PubMed–were used for the literature search. Initial criteria included articles published within the past ten years (2001–2012) in academic journals. The terms breastfeeding or breastfed and obesity used in combination produced 3,522 results from within the three databases. An additional filter limited the search to articles that included children from birth through five years of age. As a result, the number of items decreased by almost 50% to final 1,760 articles. Next, abstracts of these articles were reviewed for relevance to this study.

The final number of resources changed, as research studies, meta-analyses, and commentaries referenced sources that were not captured in the initial search.

Breastfeeding and childhood obesity

Definitions. The relationship between breastfeeding and risk for obesity gained significant attention over the past ten years as research explored the risks, as well as protective factors associated with childhood obesity (Butte, 2009; Grummer-Strawn & Mei, 2004; Grummer-Strawn, Scanlon, & Fein, 2008; Harder, Bergmann, Kalischnigg, & Plagemann, 2005; Owen et al., 2005; Sharma, Cogswell, & Li, 2008; Twells & Newhook, 2010; Weyermann, Brenner, & Rothenbacker, 2007). While a number of studies reported an association between breastfeeding and a reduced risk of childhood obesity, meta-analyses of peer-reviewed literature revealed equivocal or contradictory results. As noted earlier, differing definitions, small sample size, homogenous samples, weak designs, and inconsistent metrics and measuring tools were cited as some of the issues that confounded and limited the interpretation of results (Arenz, Ruckerl, Koletzko, & von Kries, 2004; Owen et al., 2005, Monasta et al., 2010).

Few studies examined the relationship between exclusive breastfeeding and childhood overweight and/or obesity. Within the limited number of published studies, the definition of exclusive breastfeeding varied and often lacked reference to any standard. Twells and Newhook (2010) compared exclusively breastfed infants with formula-fed infants in a sample (N=1,026) from Newfoundland and Labrador. The authors defined exclusive breastfeeding as “only breast milk (no formula, juice, water) up to and including the age of three months” (p. 37). Another study conducted in Ontario defined exclusive breastfeeding within a period of four weeks, yet explicitly allowed water and medications (Goldfield et al., 2006). Shealy, Scanlon, Labiner-Wolfe, Fein, and Grummer-Strawn (2008), who examined breastfeeding practices among U.S. mothers between 2005 and 2007, defined exclusive breastfeeding as feeding infants "nothing other than breast milk" (p. 551). Another definition of exclusive breastfeeding as "not supplementing with formula, evaporated milk, or solid food" was used in a study investigating the effect of breastfeeding on a mother's weight gain pattern over time (Michels et al., 2007). Grummer-Strawn, Scanlon, and Fein, (2008) used a category defined as "breast milk only" in their study documenting transitions in feeding during the first year (p. S37).

According to Dalenius, Borland, Smith, Polhamus, and Grummer-Strawn (2012), the PedNSS program defines exclusive breastfeeding as infant receiving only breast milk" (pg. 4). The CDC website provides additional information on the definitions and measurements used in the PedNSS program, including details on the history and features of the PedNSS program and posts-aggregate data tables and reports, along with definitions and measurements of all health indicators. The PedNSS web page updated on October 29, 2009, defined exclusive breastfeeding "… as an infant's consumption of human milk with no supplementation of any type (including infant formula, cow's milk, juice, sugar water, baby food, and anything else, even water), except for vitamins, minerals, and medications."

The CDC web page noted that the definition is consistent with the American Academy of Pediatrics Policy Statement on Breastfeeding and the Use of Human Milk

(AAP, 2005). Further, it explains that breastfeeding exclusivity is determined in the PedNSS database by "…using responses from the Introduction to Supplementary Feeding data item. This data item indicates the age of the child when he or she was first fed something other than breast milk and denotes the level of exclusive breastfeeding in the PedNSS population" (CDC, 2009). For the purposes of this research project, the design included the PedNSS definition and method of calculating exclusive breastfeeding.

Effect. A number of studies examined a potential effect of breastfeeding on a child's risk for overweight and/or obesity. As mentioned earlier, the differences in definitions, metrics, and populations have limited the ability to compare results and build a solid base of science with which to inform practice, education, and policy. Of particular relevance to this project are those studies that considered the effect that breastfeeding and exclusive breastfeeding might have on the risk for developing overweight or obesity within the first three to four years of life.

The Life Course Health Development (LCHD) model, which is discussed in further detail at the end of this chapter, views the health trajectory as being shaped by intrinsic and extrinsic factors, as well as the interaction between the two. Within the LCHD perspective, research studies that measured an outcome variable, such as BMI, weight, or body contour, six to 42 years after cessation of breastfeeding raise certain questions. Specifically, are study designs and statistical methods able to control for the array of confounding and covariant factors over the life course? The complexity of childhood overweight and obesity presents significant challenges in developing robust research designs and methods for understanding the dynamics inherent in this disorder.

An innovative study by Metzger and McDade (2010) explored the relationship between breastfeeding and reduced risk of obesity in U.S. children using a sibling difference model. Although the outcome variable (age- and gender-specific BMI z-score) was measured between nine and 19 years of age (average age of 14 years), the design provided control for numerous childhood factors. The authors explained that the sibling difference models used the differences between siblings as the dependent and independent variables in the logistic regression modeling.

The analytic study sample included 976 U.S. children, of which there were 118 "discordant sibling" pairs where one sibling was breastfed and the other sibling was not breastfed. Results of descriptive statistical analysis revealed significant differences in mean BMI z-scores (p <.001) between children who were breastfed (x =.46) and those who were never breastfed (x = .64). Inferential statistical analyses were conducted using ordinary least squares (OLS) and logistic regression models to examine the effect of breastfeeding on the risk of overweight (BMI $\geq$ 85%) and obesity (BMI $\geq$ 95%). Results suggested that breastfed infants were 41% less likely to become overweight (AOR =0.59, p <.01). However, the adjusted odds ratio (AOR) for breastfeeding was not statistically significant for predicting obesity.

Of note are three issues related to limitations of Metzger and McDade (2010) study. First, the BMI z-scores were calculated using a statistical program "zanthro" that is based on the 1978 CDC norms. While the 1978 normalized version of the 1977 National Center for Health Statistics (NCHS) curves enhances the ability to describe a relative status of children at extreme ends of the distribution curve, and was used widely for research purposes, the 1977 NCHS growth curves were based on a non-representative population sample (Kuczmarski et al., 2002). The authors did not address the decision to use “zanthro” for their analysis when programs based on revised norms were available. Further, breastfeeding data were categorized as either breastfed or never-breastfed, without explicit definitions for each term and lacking an account for the length of time a child might have been breastfed. Finally, the sample of discordant sibling pairs (n=118), was reduced further in certain analyses to 30–44 cases. Although a statistically significant effect was measured in the fixed method models, despite reduction in power, the authors suggest using caution when interpreting the results.

Burdette and Whitaker (2007) studied the relationship between breastfeeding and obesity in 2,146 preschool children born between 1998 and 2000. Specifically, the study was designed to determine if the relationship differed by race and ethnicity in a sample of preschool children from 20 U.S. urban locations. A similar study by Kimbro, Brooks-Gunn, and McLanahan (2007) used the same data set, which is discussed under the race and ethnicity section on page 55.

The sample for Burdette and Whitaker’s study (2007) consisted of 55% black non-Hispanic children, 25 % Hispanic children, and 20% white non-Hispanic children, with 52% males and 48% females. Three categories of breastfeeding were predetermined: never breastfed, breastfed < four months, and breastfed ≥ four months. Breastfeeding, however, was not defined in the article reporting the study’s results. The authors referred to other sources for details on The Fragile Families and Child Wellbeing

Study survey that was used to collect breastfeeding histories from participating mothers and child anthropometric measurements.

The outcome variable, obesity, was defined as having a BMI $\geq$ 95 percentile in reference to the 2000 CDC growth reference. Children were measured in their homes at or around three years of age. These measurements were used to calculate BMI percentile and z-score for age and sex. In addition to race and ethnicity, other independent variables included mother's age at the birth of the child, relationship status, education, income, maternal BMI, and smoking history during pregnancy.

The results indicated that the rate of breastfeeding, as reported in the survey, was similar among Hispanic (42%) and non-Hispanic white mothers (65%), while non-Hispanic black mothers reported a much lower rate of breastfeeding (42%). Mothers with a higher BMI were also less likely to breastfeed and more likely to have children with higher BMI z-scores. Logistic regression models examined an interaction between breastfeeding and race/ethnicity. Analysis also revealed a statistically significant interaction between race/ethnicity and breastfeeding (likelihood ratio statistic = 8.24, df =2, p =.02), which remained significant when breastfeeding was used as a binary (p =.01) or a continuous variable (p = .03). Breastfeeding was associated with lower prevalence of obesity among Hispanic children, compared to their black and white counterparts. However, no statistically significant association between breastfeeding and obesity appeared among black or white children.

Breastfeeding duration was another independent variable measured in obesity research studies. Procter and Holcomb (2008) conducted a study using linked data from the Kansas State Pregnancy Nutrition Surveillance System (PNSS) and the Pediatric Nutrition Surveillance System (PedNSS). These data sets represented low-income families participating in the Special Supplementary Nutrition Program for Women, Infants, and Children (WIC). Their research explored the relationship between breastfeeding duration and childhood overweight at four years of age. The results of their study also informed the state-administered WIC program.

Linked data provided 3,692 cases for their analytic sample. The race and ethnic distribution in the analytic sample differed significantly from PedNSS cases without a link to maternal PNSS data ($\chi^2 = 94.721$, $p = \leq .001$). This may be a result of the significant difference in size of the two samples. The PedNSS-only sample was 84% larger (N = 22,809) than the linked PedNSS and PNSS sample (N = 3,692). The analytic sample consisted of 58.2% white, 11.6% black, 28.1% Hispanic, 0.8% American Indian, and 1.3% Asian women and children.

At the time of their study, breastfeeding data was not reported in a manner that allowed distinction between exclusive breastfeeding from breastfeeding supplemented with formula. Therefore, the breastfeeding group that was compared to the formula fed infants would potentially include a range from exclusively breastfed infants to breastfed infants who received significant supplementary feedings. In their study, six categories measured breastfeeding duration in weeks, from 0 to 52 or more weeks (12 months or longer). However, in the final analysis, breastfeeding duration was recoded into three categories that provided a more even distribution of cases. The dependent variable (BMI at four years) was defined by four BMI measurement categories. In this study, a BMI between 85th to the 94th percentile defined the risk for overweight category and a BMI at the 95 percentile or higher defined the overweight category. These definitions do not reflect current standards.

Five variables were used in the logistic regression analyses: gender, race/ethnicity, birth weight, maternal prepregnancy BMI, and breastfeeding duration or not breastfed. Measured independently, results suggested a statistically significant protective association between breastfeeding duration and overweight at four years of age for all non-Hispanic (OR=0.72; 95%; CI =0.55, 0.94) and for white participants only (OR=0.68; 95%; CI = 0.50, 0.92). When other factors were included in the regression model, the risk profile for overweight at four years included Hispanic ethnicity, male gender, high birth weight, high prepregnancy BMI, and supplementing breastfeeding with formula.

Another study examining the relationship between infant feeding and adult obesity proposed that late introduction of complementary feeding (spoon-feeding) rather than duration of breastfeeding might protect against adult overweight (Schack-Nielsen, Sorensen, Mortensen, & Michaelsen, 2010). The study collected childhood BMI measurements on a sample of children (N= 5,068) who were born between 1959 and 1961, and followed by the Copenhagen Perinatal Cohort study.

Adult overweight was defined as a BMI $\geq$ 25 at age 42. Childhood measurements were transformed into BMI *z*-scores by using the British 1990 growth references, adjusted for sex and exact age. Breastfeeding information was collected through an interview conducted with the mother when the child was one year old. The authors reported that because of issues with accurately recording exclusive breastfeeding data in the survey, they were unable to use these data from the study. Duration of breastfeeding was recorded in weeks using an 11-category scale. Introduction of supplemental feeding was defined offering a child spoon-feedings, vegetables, eggs, meat, and firm food. As noted in previously mentioned studies, maternal smoking, maternal prepregnancy BMI, and child's birth weight were included as covariates, along with other factors not considered for this study, such as mothers' marital status and preterm birth status. Education was included but defined as the "breadwinner's education."

Logistical regression analysis indicated that the longest duration of breastfeeding ($p < .001$) and the latest introduction of spoon-feeding ($p = .082$) were observed within the normal weight group. In one model, BMI z-scores were regressed from 1 to 42, on duration of breastfeeding including only those cases (n=2,884) with information on all covariates. The model was then adjusted for age at the introduction of spoon-feeding and the results indicated an inverse association between duration of breastfeeding and BMI z-score at one year of age (β: -0.022; 95%; CI: -0.041, -0.003), but not at 42 years. In comparison, when the same analysis was conducted while replacing breastfeeding with spoon-feeding, yet only adjusting for sex, significant or borderline significant ($p < 0.100$) inverse associations were observed at six points in childhood, at 14 years of age, once in young adulthood (20-34), and at 42 years of age. However, when adjusted for all covariates, only the associations at age 14, 20–34, and 42 years were significant (statistical data not provided).

The authors concluded that a longer duration of breastfeeding was associated with a lower BMI z-score at one year of age, yet no association was measured between breastfeeding duration and the BMI z-score in adulthood. However, the researchers also observed that a longer duration of breastfeeding was associated with higher levels of economic, social, and educational indicators; lower prepregnancy BMI; and absence of smoking during pregnancy. These three covariates are also addressed in this study.

In addition, in the discussion, the timing of change in prevalence of obesity in the study sample was highlighted. During the school-age period, the overweight prevalence was at a single digit (3-5%) level. By 42 years of age, 35% of women were overweight and 51% of men were overweight. The timing of this change suggests that exposures during young adulthood may have a stronger effect on adult obesity.

Exclusive breastfeeding (EB) is the preferred nutrition for early infancy; however, few studies explore its relationship to child overweight and obesity. The Promotion of Breastfeeding Intervention Trial (PROBIT) is one of the first intervention-based studies based on the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) Baby-Friendly Hospital Initiative. Conducted in Belarus, the study represented 17,046 healthy breastfed infants enrolled through 31 hospitals. PROBIT was designed to promote and support breastfeeding, targeting mothers who chose to initiate breastfeeding. Kramer et al. (2007) analyzed the data to determine if the intervention designed to promote exclusive and prolonged breastfeeding affects children’s height, weight, adiposity, and blood pressure at six and a half years of age.

A sample of 13,889 of subjects enrolled at birth was followed up at 6.5 years. Of this sample, 7,108 had been randomly assigned to the experimental group and 6,781 had been assigned to the control group when originally enrolled in the study. Anthropometric measurements were taken and recorded in duplicate, then averaged. Covariates included maternal age, education, and smoking history during pregnancy. Covariates related to the child included gender, birth weight, and a residence of an older child in the home. The outcome measurement of BMI was calculated based on the 2000 CDC standards and compared proportions of children in the BMI ≥ 85 percentile and the ≥ 95^{th} percentile. The authors did not assign a label to these categories (e.g., overweight, obese).

In their study, Kramer et al. (2007) recounted results of their previous studies. Previous results indicated that promoting exclusive and prolonged breastfeeding resulted in a statistically significant increase in both. The level of exclusive breastfeeding (43.3%) at three months of age in the experimental group was seven times higher than in the control group (6.4%). In the PROBIT study, however, the differences in outcomes between the two groups were analyzed using a mixed-model method.

The proportions of children at 6.5 years of age with BMI ≥ 85th percentile did not vary between the experimental group (13.4%) and control groups (12.2%). Similarly, the two groups had similar proportions of children with BMI ≥ 95th percentile (5.9% and 5.0%, respectively). Using multiple linear regression, the authors compared two groups representing the extreme ends of the breastfeeding spectrum: those who weaned within one month (n= 1,136) and those who were exclusively breastfed for six or more months and continued breastfeeding for 12 or more months (n = 215). The results indicated that the group with exclusive breastfeeding and prolonged breastfeeding had significantly higher mean BMIs [cluster-adjusted difference: 0.3 (95% CI: 0.4, 0.5)], as well as significantly higher triceps' skin-fold thicknesses and systolic blood pressure compared to those weaned within a month.

Twells and Newhook (2010) conducted a cross-sectional study using data collected from families attending 2005 pre-kindergarten fairs in urban areas of Eastern Canada and who volunteered to participate (N=1,026) in the research project. For the study, the researchers selected children who were registered to begin Kindergarten in 2006 and at the time were 4.5 years old, on average. Their height and weight were measured at the fair, and their parents responded to a questionnaire that collected data on demographics and other covariates. The measurements were used to calculate the outcome variable, which was BMI for age and gender, based on the CDC growth references. Maternal variables included education and smoking history. The covariates for children were gender and gestational age. Breastfeeding data was measured at four levels: imitated breastfeeding, exclusively breastfed, exclusively formula fed, and a mix of breast and formula feeding. Race/ethnicity or other social-economic indicators were not recorded.

The outcome variable was classified into three categories: normal weight (BMI < 85th percentile), at risk for overweight (BMI ≥ 85 percentile) and overweight (BMI ≥ 95 percentile) as defined by CDC. However, in the results narrative section and in a table reporting results of the logistic regression analysis, the dependent variable is labeled obese, and defined as BMI ≥ 95th percentile. In both unadjusted and adjusted models, exclusive breastfeeding up to and including three months of age had a protective effect on the risk of obesity at 4.5 years of age [UOR: 0.67 (95% CI 0.47-0.96), and AOR: 0.66 (95% CI 0.45-0.97) respectively].

In summary, the literature search identified few studies that explored the relationship between breastfeeding and risk for overweight and obesity in children under four years of age and even fewer that examined the relationship between exclusive breastfeeding and a risk for overweight and/or obesity in children younger than four years. The differences in definitions of overweight, obesity, and breastfeeding compound the limitations of these studies. However, the research included in this review supports the inclusion of the covariates identified for this study.

Body Mass Index (BMI)

Research studies found in the literature provided conflicting results on childhood overweight and obesity risk factors. Variations in definition of terms, as well as differing and arbitrary cut-offs based on dissimilar reference populations, contributed to the incongruent results. More importantly, no single clinical tool metric directly measures obesity. The Body Mass Index (BMI) does not measure fatness or adiposity. Rather, BMI is described as a relatively blunt measurement instrument because it only considers the relationship between height and weight, but not adiposity (Toschke, Kurth, & von Kries, 2008).

However, a cross-sectional study by Freedman et al. (2009) investigated the validity of using BMI to screen for overweight and obesity in a sample (N= 1,196) of healthy children between five and 18 years of age who lived in the New York City area. While the non-representational sample is a recognized limitation of the study, the method of evaluating BMI values provided additional support for using BMI as a valid and reliable screening tool. The study revealed that 75% of boys and 80% of girls with a BMI for age at or above the 95th percentile had elevated body fatness, as measured by dual-energy X-ray absorptiometry. The results also showed less inter-measurement consistency in the group of children with BMI for age between the 85th and 94th percentiles.

The American Medical Association, in collaboration with Health Resources and Services Administration (HRSA) and the CDC U.S. Expert Committee, released recommendations regarding obesity metrics and definitions in 2007 based on the prevailing science. First, the committee recommended the use of BMI for gender and age to screen for overweight and obesity in children two years of age and older. Next, for children two years of age and older, the committee established the definition of overweight as a BMI at or above the 85th percentile and lower than the 95th percentile for children of the same age and sex. Obesity was defined as a BMI at or above the 95th percentile for children of the same age and sex. These definitions were also adopted by CDC and considered a standard of measurement practice in the U.S. (Barlow & Expert Committee, 2007). Finally, the committee recommended that these definitions would be used in reference to the 2000 CDC growth charts for gender and age.

In 2006, WHO released new growth standards (compared to growth charts) for children 0–59 months. An international sample of infants and children followed between 1997 and 2003 constituted the reference population for these standards. Different from growth charts, these standards describe the growth of healthy children in optimal conditions. Growth standards are defined by weight for age, length (or stature) for age, weight for length (or stature), and body mass index for age. Of interest to this study, these standards are based on infants who were breastfed for 12 months and "predominantly breastfed" for four months (CDC, 2010a, p. 3).

Four years later, CDC issued a recommendation for clinicians to use the 2006 WHO growth standards for children under two years of age and continue use of the 2000 CDC growth charts for children 24 months and older. While the 2006 WHO growth standard provides an improved tracking tool for a child's growth, it also imposes new cut-off values when defining children at nutritional risk. The 2.3rd and 97.7th percentiles (or ±2 standard deviations) define the boundaries of expected, normal growth on the 2006 WHO growth standard charts. However, for children two years of age and older, the 5th and 95th percentiles remain the cut-off values on the 2000 CDC growth charts (CDC, 2010a).

Therefore, prior to these recommendations, the literature reported results of studies that used differing terms, definitions, and cut-off values to define overweight and obesity in the pediatric population. The disparate values limited comparison of results and implications for practice. A 2001 report from a follow-up study on 2,617 participants of the Bogalusa Heart Study noted that 77% of those who were "overweight" as children were "obese" in adulthood. The authors defined overweight for children as a BMI $\geq$ 95% using the 2000 CDC age- and gender-specific growth chart, which is not consistent with the current CDC and WHO definitions. However, the study's definition of adult obesity

(BMI $\geq$ 30 kg/m^2) is consistent with the current standards (Freedman, Khan, Dietz, Srinivasan, & Berenson, 2001).

As mentioned in the previous section, Procter and Holcomb (2008) conducted a secondary data analysis study using linked Pediatric Nutritional Surveillance System (PedNSS) and Pregnancy Nutrition Surveillance System (PNSS) data sets. This study explored the association between breastfeeding duration and childhood overweight. The results of the analysis are discussed earlier, however; the authors' use of terms to define categories of BMI values is relevant to this discussion. While BMI percentile for age and gender was used as the metric for identifying overweight in the sample, the authors defined BMI values between 85th to 94th percentiles on the 2000 CDC gender-specific growth chart as at risk for overweight, and values at the 95th percentile or higher as overweight. These definitions were consistent with a previous study by Grummer-Strawn and Mei (2004), which Procter and Holcomb referenced in their 2008 publication. However, these definitions are no longer considered the standard therefore; comparison of the results to studies using current definitions is limited.

Beyerlein, Toschke, and von Kries (2008) reported their findings from a German study (N = 9,368) on breastfeeding and child overweight/obesity. This study used linear, logistic, and quantile regression models to analyze the relationship between breastfeeding and BMI percentiles in a sample of children between 54 and 88 months of age. The authors used the revised CDC recommended definition of overweight (BMI $\geq$ 85 - $\leq$ 94%) and obesity (BMI $\geq$ 95%), which allows comparison with results of this study.

After the CDC published its recommendations in 2007, research projects examining childhood overweight and obesity increasingly adhered to the recommended BMI metric and definitions for childhood overweight and obesity. Ogden, Carroll, Kit, and Flegal (2012) reported results from their analysis of the latest National Health and Nutrition Examination Survey (NHANES) conducted between 2009 and 2010. This report compared national data from six different periods beginning in 1999, using the CDC and WHO standard definitions of obesity (BMI for age and gender $\geq$ 95%) in relation to the 2000 CDC growth charts for children and adolescents (2–19 years old). The cross-sectional analysis considered sex and race/ethnicity in four mutually exclusive age groups. However, the authors did not use the WHO growth standards charts when analyzing trends among children less than two years of age. Although the authors noted the WHO recommendations, they defined high weight as weight-for-recumbent length $>$ 95% on the CDC 2000 growth charts for infants and children up to 24 months. Therefore, for the purposes of this study, the design adheres to the 2007 CDC recommendations for identifying and defining overweight and obesity in children two years of age and older.

Maternal factors

Prepregnancy BMI. Exposure to risks for developing overweight or obesity may occur at any point along the lifetime continuum beginning in utero. A number of studies examined the association between childhood obesity and parental BMI levels. The following review supports the decision to include maternal prepregnancy BMI as an independent variable in this study.

Whitaker et al. (1997) reported that children less than three years of age had a higher risk of obesity in adulthood if one of their parents was obese (OR 3.2, 95% CI 1.8–5.7) and were at an even higher risk when both of their parents (OR 13.6, 95% CI 3.7–50.4) were obese. However, adult obesity was defined as a BMI 27.8 for men and 27.3 for women, which predates the 1998 National Institutes of Health's release of clinical guidelines that established a BMI cut-off of 30kg/m2 as the standard definition of obesity.

Later, Whitaker (2004) conducted a retrospective cohort study using data from 8,494 child cases enrolled in the Ohio state Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) between 1992 and 1996. The purpose of the study was to determine if maternal obesity in early pregnancy was associated with a child's risk for obesity at two and four years of age. Similar to this research project, Whitaker's design included linking each child's data to his or her maternal data file. Maternal obesity was defined as a BMI > 30kg/m2. Analysis revealed that children born to mothers with a BMI between 30 and 39.9 kg/m2 had a relative risk of obesity that was more than twice as high (OR 2.28, 95% CI 1.84–2.83) as compared to children born to a mother with a BMI within the normal range. Further, the relative risk for obesity continued to increase. The relative risk at three years, (OR 3.06, 95% CI 2.49–3.76) was greater than at two years, and at four years of age, the relative risk (OR 3.07, 95% CI 2.48–3.79) was higher than at two years and three years.

Olson, Demment, Carling, and Strawderman (2010) also examined the association between maternal weight characteristics as predictors of a child's weight at four years of age. The sample of 622 women recruited from a health network of primary care clinics in a rural district of New York state were followed from early pregnancy to two years postpartum. A final sample of 321 cases with linked child data was used for analysis. Child BMI values of >85th to < 95th percentile were defined as overweight and BMI values ≥ 95th percentile were defined as obese. The analysis revealed significant and positive association (OR = 2.268, p = .001) between maternal early pregnancy BMI and the child's risk for obesity at four years of age. The mother's early pregnancy weight did not appear to be associated or predict a child's risk for overweight at four years. A limitation to the reported results from this study is the lack of maternal age and race/ethnicity, which limits the interpretation of these results. Further, this sample was recruited from a primary care network, which reflects a population with access to prenatal health care.

Kitsantas and Gaffney (2010) conducted a secondary data analysis that examined a combined effect of risk factors for overweigh and obesity. The authors used data from the Early Childhood Longitudinal Study-Birth Cohort (ECLS-B), from which 6,540 cases met the inclusion criteria. The potential risk factors included maternal age, marital status, race/ethnicity, education, parity (at time of birth), prepregnancy height and weight, socio-economic status, and tobacco use during pregnancy. Child anthropometrics were measured and recorded at two and four years of age. Finally, the history and duration of breastfeeding was measured in months.

For this study, Kitsantas and Gaffney (2010) defined normal weight as a BMI-for-age value between the 5th and < 85th percentile, overweight as a BMI value between

85th and < 95th percentile, and obese as any BMI value ≥ 95th percentile. The study used classification and regression tree (CART) analysis to examine the combined effect of risk factors on the likelihood of developing overweight and obesity. Results indicated that a mother who was overweight or obese before pregnancy had a higher odds (OR= 1.60, p = 0.00) of her child being overweight or obese at four years of age.

Prenatal care initiation. The literature indicated timing of prenatal care is associated with maternal and child outcomes. Shoff, Yant, and Mathews (2012) reported findings from a study exploring U.S. prenatal care utilization, according to which uninsured women are more likely to receive late or no prenatal care. The Pregnancy Nutrition Surveillance System (PNSS) gathers data on mothers enrolled in Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). WIC programs limit enrollment to women and children at or below 185 percent of the federal poverty level (USDA, 2011). Therefore, this population may be at risk for untimely prenatal care initiation. Delay in prenatal care initiation has implications for exclusive breastfeeding.

Stuebe and Bonuck (2011) used data from two, ongoing randomized controlled trials to study the association between intentions to exclusively breastfeed and maternal knowledge and attitudes towards breastfeeding. Their study sample of 883 lower-income women were predominantly Hispanic (59.9%) or non-Hispanic black (31.6%), with 46 percent enrolled in WIC. Data analysis revealed that mothers who received the breastfeeding promotional intervention demonstrated more knowledge about breastfeeding benefits, which was significantly associated with prenatal feeding intensions. For example, mothers from the intervention group who disagreed with the statement "Infant formula is as good as breastmilk" were more likely to indicate intentions to exclusively breastfeed (OR 3.44, 95%CI 1.80-6.59). The authors suggested that early prenatal care that included breastfeeding education could improve exclusive breastfeeding rates among low-income, minority women.

Smoking history. Maternal smoking represents exposure to an adverse factor for the mother, fetus, and baby. Several studies that examined issues related to childhood overweight and obesity included maternal smoking as an independent variable or covariate (Grummer-Strawn & Mei, 2004; Kitsantas & Gaffney, 2010; Olson et al., 2010; Sharma et al., 2009; Taveras, Gillman, Kleinman, Rich-Edwards, & Rifas-Shiman, 2010; Twells & Newhook, 2010). Sharma, Cogswell, and Li (2008) conducted a study on the dose-response association between maternal smoking during pregnancy and childhood obesity. Specifically, the study examined if the association between smoking during pregnancy and a risk for childhood obesity varied between race and ethnic groups in a sample of a low-income mothers and children. The outcome variable (child BMI percentile > 95 for age and gender) was measured between two to four years of age with a mean age of 36.9 (9.3) months.

In their study, Sharma, Cogswell, and Li (2008) used Pregnancy Nutrition Surveillance System (PNSS) and Pediatric Nutrition Surveillance System (PedNSS) linked data files, which provided a sample of 134,835 mothers and 155,411 children from nine U.S. states and two tribal nations. While 71.3% of children in this sample were born to nonsmokers, 14.5% of children had mothers who smoked prior to pregnancy and then quit during pregnancy. Another 14.1% of children had mothers who smoked throughout the pregnancy.

The results also revealed that non-Hispanic white mothers had the highest rate of smoking during pregnancy, which was associated with the increased likelihood that their child was obese (OR, 1.37, p. <0.0001). American Indian or Alaska Native, and Asian or Pacific Islander mothers had the lowest rate of smoking during pregnancy and the lowest likelihood of their child being obese.

In a study that investigated the combined effect of maternal and early childhood factors in developing overweight/obesity risk profiles, Kitsantas and Gaffney (2010) reported that chi-square analysis indicated a significant association between maternal smoking during pregnancy and a pre-school child's BMI status. Next, the authors used logistic regression and classified regression tree (CART) analyses to examine the combined effect of a combination of maternal and child risk factors, including smoking during pregnancy. However, analysis revealed maternal smoking did not contribute to the prediction of preschool overweight/obesity in this sample, as indicated by the odds ratio = 1.21 (95% CI 0.95, 1.04), $p = 0.32$.

Socio-economic status and education. Although families participating in WIC must meet a specified economic criteria, the literature indicated uncertainty regarding the effect of socio-economic and or education factors in the risk for overweight and obesity.   In a cross-sectional study conducted by Ogden, Carroll, Kit, and Flegal (2012), analysis of NHANES data from 1999 to 2010 revealed relatively no change or even a slight decrease in prevalence of obesity in children of low-income families.

Specifically, between 2002 and 2007, the prevalence of obesity in children six to 13 years of age appeared to have leveled off from its previous upward trajectory. However, the results of this study were interpreted in relation to the overall slowing in prevalence of childhood obesity and did not indicate that the effect of socio-economic status diminished during that period.

Martin, Frisco, Nau, and Burnett (2012) challenged the assumption of income as an independent factor in the U.S. adolescent overweight. First, they referred to previous studies that did not demonstrate a significant association between family income and adolescent overweight and obesity. They proposed that income and education levels are regarded as having a similar association with adolescent weight because they are often studied together as indicators. The authors questioned whether there might be a difference in how family education and income levels correlate with adolescent obesity.

The authors also suggested that certain economic forces, which correlate with adolescent obesity, might exist in other social contexts such as schools. They used data from Wave 1 of the U.S.-based National Longitudinal Study of Adolescent Health, representing data collected from 132 schools and 16,133 subjects between 1994 and 1995. The dichotomous outcome variable of overweight or obesity was defined as a BMI > 85^{th} percentile. Parental education was measured as the number of years of completed schooling, while income was categorized as poor or not, based on the family's composition and the U.S. Census Bureau official poverty thresholds for 1994.

Descriptive statistics illustrated the distribution of variables within the study sample. Participants were predominantly white (64.7%), with 93.4% of all participants born in the U.S. Average parental education exceeded 12 years of schooling (13.2); however, fewer than 20% of parents in the poverty category reported education beyond 12 years. School-level poverty measured 19.8%, compared with individual family income poverty level of 19.6%. Racial/ethnic composition differed between individual and school levels. School-level demographics reported a slightly lower proportion of white students (60%) and higher African American composition (21.2%) compared with the individual family composition, in which African American families made up 15.5% and white families were at 64.7%. This discrepancy may indicate a difference in the number of children in these racial/ethnic groups.

The results of the hierarchical logistic regression analysis demonstrated that at the family level, parents' education (R^2= -0.055, F(0.01), $p < .001$) but not poverty status (R^2= -0.040, F(0.09), $p > .05$) was associated with adolescent overweight. However, in a third model, the concentration of poverty within a school (R^2 =0.013, F(0.004), $p <.01$) but not median parental education (R^2 = -0.049, F (0.03), $p > .05$) was also associated with adolescent overweight. Other studies have used education or a combination of income and education as an independent variable.

Sing, Siahpush, and Kogan (2010) reported a statistically significant difference in the prevalence of obesity among several parental educational level categories. Their analysis revealed that obesity was 3.1 times more prevalent in children whose parents had fewer than 12 years of education than those children whose parents had a college education. In another study, Kitsantas and Gaffney (2012) used a socioeconomic status (SES) variable derived from parental income and education levels. The results of their study revealed that 41.2 % of children in low SES category were overweight or obese, whereas only 28.6% of children in high SES category had BMI percentiles within the overweight/obese range.

Finally, Dupre (2008) conducted a study on educational differences in health risks and illness over the life course. Using data from the NHANES-1 data set, the study measured the effect of education on case-fatality rates of hypertension and heart attack in adults. The design included 20 years of longitudinal data on social and economic risks, such as gender, race, employment status, marital status, and household income. Statistical analysis suggested that education was related to both individual and accumulated number of behavioral, social, and economic health risks. Low educational attainment was related to unhealthy BMI ($p \leq .001$), smoking, low income, unemployment status, and non-married status. Further, low educational levels were associated with cumulative disadvantage, which manifested in an accelerated rate of health decline.

As discussed earlier, Kansas PedNSS and PNSS obtained 100 percent of their data from families participating in the state WIC program. These families met a specified economic need level, which during the time of data collection, was an annual income at or below 185 percent of the U.S. Poverty Income Guideline. Therefore, the study sample for this project represented a low socioeconomic population. Using education level as an independent variable in this study offered an additional factor with which to study the relationship between exclusive breastfeeding and childhood overweight and obesity.

Race and Ethnicity. Health disparities are reported among different socioeconomic as well as race and ethnic groups. Between 2007 and 2008, more than nine percent (9.5%) of infants and toddlers two years of age and younger reported in the National Health and Nutrition Examination Survey (NHANES), were at or above the 95th percentile in weight for recumbent length. Within this age group, Hispanic children had the highest proportion (12.5%) followed by non-Hispanic black (10.3%), Mexican American, (9.2%), and non-Hispanic white (8.7%) children (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). A study by Kimbro, Brooks-Gunn, and McLanahan (2007) also explored racial/ethnic differences in overweight and obesity using The Fragile Families and Child Wellbeing Survey Study data set, which consisted of a national sample (N= 1,976) of parents and their children, living in 20 large U.S. cities. The survey oversampled unwed mothers, with non-Hispanic black (55%) representing the largest portion of the sample, Hispanic (25%) the next largest group, and non-Hispanic white (20%) the smallest group. Children's height and weight were measured at or around one and three years of age. Using the three-year-old measurements (mean age 36.0 months), a BMI for age and gender was calculated for each child.

The study design included multiple contextual factors, including maternal weight and mental health, food insecurity level, opportunities for exercise, process for obtaining everyday food, and breastfeeding. However, for the purposes of this discussion, the method for examining racial/ethnic differences in overweight and obesity in this study sample was especially important. Within this study sample, 35% of the children were overweight (> 85%) and obese (> 95%) for age and gender on the 2000 CDC growth charts. Of those overweight and obese, the proportion of non-Hispanic black and non-Hispanic white children were similar (32%), compared to 44% of Hispanic children. A high prevalence (67%) of maternal overweight and obesity was also observed. However, non-Hispanic black mothers had the highest rate of obesity (46%) compared to Hispanic mothers (40%) and non-Hispanic white mothers (28%).

Two years later, and analyzing data from the same database (NHANES) that was updated for years 2009–2010, Ogden, Carroll, Kit, & Flegal (2012) reported statistically similar (9.7%) overall prevalence in overweight and obesity in the same age group, with 14.8% of Hispanic and 15,7% of Mexican American males at or above the 95th percentile in weight for recumbent length. However, the study also revealed, a statistically significant increase in BMI measures among males two to 19 years of age, between 1999 and 2010.

Considering these findings, Singh, Siahpush, and Kogan (2010) examined potential differences in obesity and overweight among children and adolescents from a racial/ethnic and socio-economic perspective. This study used the National Survey of Children's Health data set, which reported data collected on children from birth to 17 years of age. The authors analyzed data from a subgroup of children ages 10 to 17 years old (N= 46,707) who participated in the 2003 survey and a second cohort of 10 to 17 year olds (N=44,101) who participated in the 2007 survey. The analysis revealed substantial racial/ethnic disparities in the sample. In 2003, non-Hispanic black children had the highest rate of obesity (23.45%) compared to non-Hispanic whites (12%) and Hispanic (18.4%) children. However, by 2007, the proportion of obese Hispanic children

(23.42%) had increased dramatically and reached similar proportions of non-Hispanic black children (23.86%). In the 2007 cohort, children from Hispanic, non-Hispanic black, and American Indian families had 3.4 to 3.8 times higher odds of obesity compared to Asian children.

Similar results have been obtained in other studies as well (Burdette & Whitaker, 2007; Bethell, Simpson, Stumbo, Carle, & Gombojav, 2010; Ogden, Lamb, Carroll, & Flegal, 2010; Taveras, Gillman, Kleinman, Rich-Edwards, Rifas-Shiman, 2010; Wang, 2011). The 2010 U.S. Census report documented a significant increase in the minority children population. Hispanic children represented the largest absolute increase of minority children. In light of these facts, Hispanic children and particularly Hispanic males represent a population at significant risk for developing childhood obesity.

Studies examining the association between parental or maternal BMI and the child's subsequent risk for overweight and obesity often involved largely non-minority populations or did not detail the race/ethnicity of the study sample. In a study by Steffen, Dai, Fulton, and Labarthe (2009) involving 526 children in Texas, 20.1% were identified as black and 79.9% were categorized as non-black. A study by Whitaker, Jarvis, Beeken, Boniface, and Wardle (2010) used data from an annual cross-sectional national survey representative of private English households. The ethnicity of the large sample (N=7,078) included 79% white, 2.6% black/black British, 14.1% Asian/Asian British, with the remaining categorized as unknown or other. A third study of 329 children conducted in Western Australia found that maternal BMI and single-parent family structure were significant predictors of high child BMI z-scores (Gibson, et al., 2007).

However, neither ethnicity nor race categories of this sample were included in the reported results.

A systematic review of the literature, conducted by Dixon, Pena, and Taveras (2012) within a Life Course Health Development framework, also indicated that children from racial/ethnic minority families were significantly more likely to be obese and experience related adverse sequelae. The independent effect of race/ethnicity was not explicated. Likewise, Braverman and Barclay (2009) proposed and demonstrated that health disparities among racial and ethnic groups also differ according to socio-economic levels. Specifically, children of minority populations may experience a greater risk for poor health trajectories than the risk observed in white non-Hispanic children. Further, within Hispanic children, those in families at lower socio-economic levels experience even greater risk of poor health, compared to Hispanic children at higher SES levels.

Child factors

Studies that examined predictors of childhood obesity reported an array of child related risk factors. The following are studies not referenced or not completely explicated in previous sections however provided additional support for inclusion of gestational weight, breastfeeding history, exclusive breastfeeding history, introduction of supplementary foods, and exclusive breastfeeding as independent variables in this research project.

Early life predictors may vary within certain groups. Observed and reported racial disparities in early childhood overweight and obesity prompted Weden, Brownell, and Rendall (2012) to examine disparities between non-Hispanic black and non-Hispanic white children in the U.S. The authors proposed that previous studies were limited in scope of contributing factors as well as a lack of detailed measurement. Their study analysis included an analytic sample of 3,300 children from the Early Childhood Longitudinal Study 2001 birth cohort and 3,106 children from the Children and Young Adults of the National Longitudinal Survey of Youth 1979 cohort. This sample represented children born in the U.S. between 1986 and 2001, a span of 15 years.

Five of the seven maternal variables in the Weden, Brownell and Rendall study were similar to the factors included in this study with the exception of marital and employment status. Their infant variables included three of the variables proposed in this study: birth weight, gestational age at birth, and breastfeeding duration. They also included birth order, childcare in first year, family meals per week, and television viewing. The outcome variable in the Weden, Brownell and Rendall study was a child's BMI percentile for age at or above the 95^{th} percentile in reference to the 2000 CDC growth charts. Approximately 70% of BMI percentiles were calculated from clinical measurements, the other 30% were calculated based on measurements reported by participating mothers.

Logistic regression analysis indicated that odds of developing early childhood obesity among non-Hispanic black children was 59% higher than odds observed in non-Hispanic white children (OR = 1.59, 95%CI[1.32,1.92], p <.001). Prenatal (maternal prepregnancy BMI) and early life factors (low birth weight, short duration of breastfeeding, or no breastfeeding) were particularly significant predictors in non-Hispanic black children.

The study by Kitsantas and Gaffney (2010) discussed in the previous section regarding maternal related variables, also included a number of child related factors relevant to this study. These child related factors included sex, gestational age, birth weight, duration of breastfeeding, and BMI-for-age percentile at age two, and were measured in the same manner as proposed in this research project. Chi-square analyses indicated significant association between duration of breastfeeding, birth weight, gestational age, and BMI at age two years. Classification and regression tree modeling identified overweight/obesity at age two years significantly increased likelihood of overweight/obesity at age four years. Further, that duration of breastfeeding longer than 2.5 months decreased the prevalence of overweight/obesity at age four years among children with certain risk profiles. Logistic regression analyses revealed similar results observed from classification and regression tree (CART) analyses, except for duration of breastfeeding.

Lamb, et al. (2010) studied a sample of 1,178 predominantly non-Hispanic white children (72.1%) from the Diabetes Autoimmunity Study in the Young (DAISY) to understand pathways of early life factors and their relation to childhood BMI. The authors included limited maternal demographic factors (age, education, and annual income) and several fetal, infant, and child-related covariates. The study design included exposure to cigarette smoke in utero, exposure to diabetes in utero, size for gestational age, exclusive breastfeeding duration, total breastfeeding duration, weight gain in first year and biological markers for diabetes susceptibility.

Exclusive breastfeeding (breast milk and water only) and exposure to smoke in utero (did or did not smoke 50 cigarettes during pregnancy) were clearly defined. The outcome variable was a child's BMI measured between two years and eleven years for girls and two to eleven and an half years for boys. The authors proposed that using a continuous BMI measure for the outcome variable was a more appropriate method for analysis and gestational size was categorized by small, normal and large, using percentiles (10^{th} – 90^{th}).

The authors reported that results of the linear, mixed-effect model analysis identified female gender, diabetes exposure in utero, large size for gestational age, shorter breastfeeding duration and more rapid infant weight gain were significant predictors of higher BMI in childhood, in their study sample. They concluded through further mediated analysis that larger birth size may partially mediate the association observed between diabetes exposure in utero and higher childhood BMI. However, this particular sample was identified as at risk for in-utero exposure to diabetes Type I.

Butte (2009) conducted a study involving 1,030 Hispanic children who lived in a large southwestern city and participated in the Viva La Familia Study between November 200 and August 2004. While the purpose of the Viva La Familia Study was to identify genetic and environmental factors affecting obesity and its comorbidities, the study design included maternal, fetal, and early infant factors also used in this study. In the Butte study, maternal covariates were education, smoking, and BMI. Infant covariates included birth weight, breastfeeding, exclusive breastfeeding, and age at which solid food was introduced were covariates used to examine risk factors in childhood obesity (BMI-for age percentile > 95).

Adjusted odds ratios from multiple logistic regression analyses identified child age, birth weight, number of children in the family, maternal and paternal obesity, and percent of sedentary awake time, were significantly risk factors for childhood obesity. The authors concluded that although breastmilk provides optimal nutrition during early infancy, other risk factors within their sample exerted significant effect, mitigating its protective effect. However, exclusive breastfeeding was a dichotomous yes/no variable and described as being the "predominant milk source" in feeding.

Finally, Proctor and Holcomb (2008) who conducted a study using linked PNSS and PedNSS data files also included four similar child-related factors as proposed in this study: gender, birth weight, breastfeeding duration, and use of formula. In their study, the entire panel of factors was significantly associated with overweight at four years of age.

Life Course Health Development (LCHD) model

Chapter 1 described the development and features of the LCHD model. The following discussion includes literature that supported the use of the LCHD model as a framework to study health phenomena, specifically childhood overweight and obesity (Ben-Shlomo & Kuh, 2002; Braverman & Barclay, 2009; Dixon, Pena, & Taveras, 2012; Lee et al., 2010; Halfon, DuPlessis, & Barrett, 2008; IOM, 2011; Wise, 2009).

As Ben-Shlomo and Kuh (2002) observed, the basic assumptions of the LCHD model appears "intuitively obvious" (p. 291). Years of study support the concept that health is influenced by myriad intrinsic and extrinsic factors, both positive and negative. Further, the cumulative, interactive, and compounding result of these factors over the life course significantly affects the level of health as well as risk for disease. However, the authors continued to build a case for developing a body of evidence that clearly explains the observed effect of these factors on health trajectories to inform research, education, practice, and policy.

They also developed three main features of the LCHD model germane to this research study. First, they distinguished the concepts of critical and sensitive periods within the LCHD model. As described by Halfon and Hochstein (2002), there are critical periods along the life course, which are especially sensitive to positive or negative events and exposures. In fact, during critical periods, exposure to an adverse event often leads to irrevocable results, such as an intrauterine exposure to a virus resulting in hearing loss. Ben-Shlomo and Kuh (2002) distinguished critical periods from sensitive stages. They proposed that in addition to time-specific, critical, and lasting effect periods, there are sensitive times when an event has a stronger or weaker effect than at another time in life. For example, the recommendation to place infants on their back during sleep resulted in observable changes in infant head contour, which may be corrected and prevented by initiating adequate "tummy time" during early infancy. The risk of a mis-shapened head because of lying supine during sleep extinguishes as infants independently roll and change positions.

Second, Ben-Shlomo and Kuhn (2002) further developed the concepts of inter-generational and population determinants of health along the life course. Therefore, prepregnancy BMI, socio-economic, and education, which exist during these periods, were important factors to include in exploring risks for childhood overweight and obesity. Finally, Ben-Shlomo and Kuhn (2002) encouraged an inter-disciplinary approach to research as well as placing research within historical context.

This study was guided by an interdisciplinary committee. It also used the LCHD model support for considering contextual forces, including the historical context in which the individuals in the WIC population lived. In summary, the comprehensive features of the LCHD model provided a strong framework for identifying and understanding risks for childhood overweight and obesity.

Halfon, DuPlessis, and Inkelas (2007) also presented a compelling argument for using the LCHD model as a framework for reforming the U.S. pediatric health care system. They referenced research that strongly suggests that prevention of and reduction in exposure to adverse events decreases a child's risk for health problems later in life. Further, the LCHD model's intergenerational perspective considers the influence of one generation's health on subsequent generations and expands the scope of potential mechanisms for research. For example, within the LCHD framework, the intra-uterine environment is viewed in terms of its significant exposure to positive and potentially negative factors. Maternal biochemical, biophysical, and psychosocial functions are recognized as mechanisms by which multiple factors may exert an effect on the fetus. Because the literature reports a significant association between prepregnancy BMI and risk for childhood overweight/obesity, the LCHD model supports the concept that prepregnancy BMI is a potential influence on a child's health trajectory. Further, the

LCHD model suggests that interventions designed to improve maternal health will also translate into healthier life trajectories for babies.

Halfon, DuPlessis, and Barrett (2008) proposed evidenced-based strategies for developing obstetrical care within an LCHD model. The strategies would focus on promoting and sustaining maternal health along the life course. Healthier women would have lower-risk pregnancies, which would translate into healthier babies, as well as a healthier life course for the mother.

Braverman and Barclay (2009) highlighted the developmental perspective of the LCHD model, which aligns with the intergenerational perspective as well as the understanding of pediatric developmental perspective. Their discussion on the evolution of health disparities focused specifically on forces and events within early childhood that contribute to observed differences in health status within the U.S. population. They explored the concept of compounding influence from both positive and adverse factors, suggesting that a dose-response effect may explain the mechanisms behind observed outcomes. However, consistent with Wise (2009) who proposed that early events are subject to considerable later influences, Braverman and Barclay (2009) maintained that the LCHD model assumes early life events shape rather than predict future health outcomes.

Braverman and Barclay (2009) also broadened the concept of health disparities in relation to the LCHD model, defining health disparities as potentially avoidable differences in health among different groups of people. Certain characteristics, such as social status, economic status, education, sexual orientation, gender, and religion, influence the disparities observed in different groups. Therefore, an LCHD approach explores how these factors enable or constrain health behaviors and outcomes in these groups.

Although the literature supported the logic and utility of the LCHD model for exploring mechanisms that improve as well as threaten health, a search of the literature produced few articles that explicitly used the LCHD model to explore pediatric issues, childhood obesity, or the relationship between breastfeeding and obesity. In one study, Michels et al. (2007) examined the association between infant feeding and obesity throughout the life course. The study utilized data from the Nurses' Health Study II, which followed a cohort of female nurses prospectively from 1989 to 2001. Mothers of nurses participating in the study were sent a questionnaire to report infant feeding history, including breast or bottle-feeding, duration of breastfeeding, exclusivity of breastfeeding, and type of non-breast milk feedings. The nurses self-reported their body shape at five and eight years of age, their weight at 18 years old, and their current, adult height and weight. The mean adult age of nurse participants was 40.5 years for non-breastfed group and 39.3 for the breastfed group.

In the sample of predominantly white female nurses, those who were exclusively breastfed were more likely to have a leaner body shape at age five, when compared to those who were not breastfed—or who were breastfed for less than one week. However, this association did not persist throughout childhood or to any point later in life. Additional analyses revealed no association between having been breastfed and the likelihood of becoming overweight or obese throughout life course, so the authors concluded that breastfeeding was “unlikely to play an important role in controlling the obesity epidemic” (p. 1084). While the study incorporates a life-course perspective, the design and statistical analysis did not control for the totality of mitigating factors within the 40-year life span. The use of self-reported weight data lacked standardization and imposed further limitations of their results.

In a large study by Lee et al. (2010), data from seven consecutive National Health and Nutrition Examinations Surveys (NHANES) were used to examine obesity prevalence over the life course in the U.S. population between 1971 and 2006. The number of cases from the seven different periods ranged between 19,775 and 7,891. Cases were organized into 10-year age groups and 10-year birth cohorts. As mentioned earlier, the results of age, period, and birth cohort analyses suggested that recent birth cohorts were obese in greater proportions for a given age and experienced a greater duration of obesity over their life course. The authors proposed that the cumulative effect of prolonged exposure to excess weight might increase the likelihood of diseases such as type 2 diabetes and lead to a shorter life expectancy.

The implications of this study are clear. However, the next step is to understand how obesity develops and persists. The LCHD model is an integrated theoretical framework with multidisciplinary roots that is used widely for health care and health policy research. Grounded in social, behavioral, and human development science, the LCHD model provides a robust and relevant research paradigm. The model supports exploration into how health trajectories are influenced by intrinsic and extrinsic factors as well as the interaction between these two domains. The data used in this study are some of the most current available on children who participate in WIC. The years 2008 to 2011 reflect a depressed economic period when unemployment was higher than in the previous 16 years, doubling since 2006 (USDL, n. d.). Finally, the collaboration with experts in epidemiology, nursing, and public health, as well as large data set research methods, enhanced the design of this study.

CHAPTER THREE: METHODOLOGY

The purpose of this retrospective secondary data analysis study was to examine the relationship between duration of exclusive breastfeeding in the first six months of infancy and a risk of overweight and obesity at three years of age using a national surveillance system data set. The Life Course Health Development (LCHD) theoretical framework favors this design method, assuming that early life events exert both positive and negative forces with potential for long-term effect on one's health trajectory. Chronic disorders, such as obesity and related health problems, may be linked to early life exposures and interactions at sensitive and critical periods (Halfon & Hochstein, 2002).

Problem and purpose of study overview

The LCHD model supports the notion that positive early life events improve the probability for an optimal health trajectory. Conversely, negative early life events may adversely affect the health trajectory, especially if compounded by subsequent adverse events along the life course. Obesity threatens a child's short-term and long-term status. The myriad factors that contribute to obesity are evident along the life course, which includes epigenetic and intergenerational influences. Therefore, identifying and promoting effective risk reduction factors that exist along the life course may improve a child's health trajectory.

For the purposes of this study, the LCHD theoretical model represents a life-long process of identifying and enhancing risk-reducing and health-promoting factors that support an individual's optimal health trajectory. Exclusive breastfeeding may convey health protective factors that mitigate the effects of other risks occurring during early childhood. An infant who receives optimum nutrition and gains appropriate weight for age and gender may experience a reduced risk of overweight and obesity during the first few years of life. Combined with other measures to continue optimal nutritional, physical, and social behaviors, exclusive breastfeeding may reduce the risk of developing childhood obesity.

Research questions

The LCHD theoretical model strengthened the design of this project by providing a framework for exploring the complex nature of childhood obesity. The following research questions addressed the proposed effect of exclusive breastfeeding on the risk for developing childhood overweight/obesity at three years of age within an LCHD perspective:

1. What associations exist between observed risk factors in the study sample and overweight/obesity at three years of age?
2. What is the association between different durations of exclusive breastfeed and overweight and obesity at three years of age?
3. Do infants that are exclusively breastfed for different lengths of time have different risks for overweight and obesity at three years of age after adjusting for maternal education level?

4. Do infants who are exclusively breastfed for different lengths of time have different risk for overweight/obesity at three years of age when other contributing factors exist?

Research design

A non-experimental, retrospective design was used to conduct this secondary data analysis study. Using a national surveillance database, this study examined if exclusive breastfeeding during the first six months of life is associated with a reduced risk of childhood overweight and obesity up to three years of age in a sample of children than participated in the Kansas state Special Supplemental Nutrition Program for Women, Infants, and Children (WIC).

The PedNSS database offered an opportunity to follow a cohort of infants/children from birth to three years of age who were seen in WIC offices every one to three months in the first year, then less frequently in subsequent years. Frequency of visits varied depending on participation in education and immunization programs. The study design also included linked maternal data, which enhanced the study's capacity to measure whether, and to what degree, maternal, social, economic, and ethnic/racial factors contribute to the risk for overweight/obesity at the infant's three years of age.

Data collection

The Kansas Department of Health and Environment (KDHE) granted permission to access its nutritional surveillance system data. This data set provided the means with which to identify a study sample and conduct a secondary data analysis study. The Pediatric Nutrition Surveillance System (PedNSS) and the Pregnancy Nutrition

Surveillance System (PNSS) are national program-based nutrition surveillance systems coordinated by CDC. Contact with the CDC's Division of Nutrition, Physical Activity, and Obesity afforded an opportunity to learn more about the data sets' attributes as well as about the process for accessing the data files. Although the data are archived at CDC, each state must receive and approve any request for access to its respective data files.

A contact made at the 2010 Maternal Child Health Epidemiology Conference in San Antonio resulted in the research author's introduction to staff at the Data Systems and Surveillance Nutrition Branch of the Division of Nutrition, Physical Activity, and Obesity at the National Center for Chronic Disease Prevention and Health Promotion (NCCDPHP). The staff provided a detailed overview of the PedNSS and PNSS data set features and assisted the author in the process of obtaining permission to use these data. This included contact information for selected state offices and officials.

A letter submitted electronically on June 1, 2011, to the Commonwealth of Virginia's Department of Health, requested permission to access its unique PedNSS child files, which would include all available data recorded in the file, the alphanumeric identifier, and date of birth for each case. Attached to the letter was an abstract of the research proposal. Approximately two months after submitting the request, the state of Virginia granted permission that allowed CDC to release the requested data files. However, the CDC staff found a systematic issue within the 2008 data file. Because the issue could not be resolved, the CDC staff recommended identifying an alternative state for this study.

The author constructed a matrix with which to review the 2010 PedNSS data national tables to identify a state with sufficient data in the main study variables. The tables displayed yearly reported aggregate state data and are publicly available on the following CDC website: http://www.cdc.gov/pednss/pednss_tables/tables_numeric.htm. Tables are updated regularly and the 2010 tables were replaced with 2011 tables on August 20, 2012.

The matrix was constructed to organize aggregate data on the following items: (1) the number of participating families; (2) participants' ethnic and racial categories; (3) participating children within the five age categories listed in the data set beginning at 0 to 5 months, and through 3 to 4 years of age; (4) infants ever breastfed; and (5) infants exclusively breastfed. The matrix included all states, territories, and American Indian nations participating in the PedNSS program. The data were entered into the matrix under each state, territory, and Indian nation participating in the PedNSS surveillance program, and then ranked in a descending order, according to levels reported in breastfeeding variables.

The first two states contacted declined the request for access to their data files. New York State declined the request, explaining that a staff member in its WIC program office was conducting a similar study using the same data set. Oregon also refused permission since the state only allowed access to its data by individuals listed on consent-to-participate forms signed by WIC families participating in the state PedNSS and PNSS programs. Therefore, the author could not request access to data reported prior to the date of the request, if approved.

Returning to the literature, a study by Procter and Holcomb (2008) reported success in accessing Kansas State data, as well as linking the maternal files to child files. After reviewing the results of the 2010 PedNSS data review tables and the 2010 Kansas Health Statistics Report by the KDHE Division of Health Bureau of Public Health Informatics, it appeared that Kansas reported significant numbers in the major study variables. In 2008, Kansas reported that 14% of three-month-old infants tracked in the state's PedNSS were exclusively breastfed, compared to the U.S. rate of 12.9% (KDHE, 2010). In 2010, Kansas WIC offices reported a total of 4,767 (14.9%) infants who were exclusively breastfed up to three months of age and 7,876 (4%) infants who were exclusively breastfed up to six months of age (CDC, 2010b). Therefore, a request to access Kansas PedNSS data files was submitted to the KDHE's Nutrition and WIC Services office on October 17, 2011, and was approved on October 18, 2011. A copy of the approval letter is found in Appendix I.

CDC delivered three data files stored on individual compact discs (CDs) using Federal Express (FedEX) shipping. Each CD contained one year's data in a .DAT file format. CDC also provided updated field definitions, codes, and edits along with record specifications and descriptors for writing electronic codes to read data into SPSS software for statistical analysis.

The literature review supported the need for maternal prenatal and socioeconomic data. On April 1, 2011, Kansas State approved a request to access the unique 2008 PNSS files, with associated maternal alphanumeric identifier codes. Following the PNSS approval, a third request was also approved for access of the 2011 PedNSS files. This final request afforded four continuous years of data that allow identification of cases born in 2008, followed through three years of age. In addition, each case with a 2008 birth date could be linked to its respective maternal file.

WIC data collection

To maintain the consistency of PedNSS data, methods for data collection and recording are set nationally and are uniform across states and participating federal programs (Sharma et al., 2009). Trained WIC staff used a high-quality beam balance or electronic digital scale for weighting infants, as well as specified equipment and procedures to measure recumbent height. Staff members also received training and supervision in collection of all PedNSS data. A recent study conducted in seven California WIC clinics by Crespi, Alfonso, Whaley, and Wang (2012) found anthropometric data to be adequately valid for tracking and research purposes. However, this study only included 287 children who were two to five years of age.

CDC routinely assesses data quality and flags errors such as data that are missing, miscoded, or biologically implausible. Flagged data are not included in PedNSS and PNSS analyses. CDC also cleans and weights data, and delivers requested files in electronic format, which allows the files to be uploaded into SPSS software program. However, CDC does not provide an electronic codebook with which to read in the data to SPSS. Therefore, the code must be created by the person(s) requesting the data.

Population and sample

The target population for this study was defined as mothers, infants, and children who participated in the Kansas WIC program from 2008 to 2011. WIC provides services to pregnant women, breastfeeding women, and non-breastfeeding women for up to six months post-partum. Infants and children up to five years of age are also eligible to receive WIC services (Kansas Department of Health and Environment [KDHE], 2009). WIC eligibility is based on a number of factors, including residency, income, and nutritional risk. An applicant's income must fall at or below 185 percent of the U.S. Poverty Income Guidelines (currently $40,793 for a family of four). Individuals are also required to show evidence that they reside in the state from which they seek assistance.

The Code of Federal Regulations (CFR) for Title 7: Part 246 details five major categories of nutritional risks that states use for screening purposes. These categories include conditions diagnosed by biochemical or anthropometric measures, nutritional related conditions, dietary deficiencies, conditions that directly affect the nutrition health of a person, and conditions that place a person at risk for inadequate nutrition (Oliveira & Frazao, 2009).

Participating infants and children are seen at a WIC program office every one to three months, which is when data for the Pediatric Nutrition Surveillance System (PedNSS) are collected. The Kansas WIC program developed unique alphanumeric codes for women participating in the Pregnancy Nutrition Surveillance System (PNSS) that links to their child's unique alphanumeric code in the PedNSS case file. Therefore, this data set supports studies that explore potential relationships between maternal variables and childhood events.

Kansas WIC programs also gathered data on breastfeeding, exclusive breastfeeding, and clinical measurements of infant/child height and weight (CDC, 2011b). The reported rate of exclusively breastfed infants in the Kansas WIC population was higher than the national rate, which enhanced its fit for this study. In 2008, Kansas reported that 14% of three-month-old infants tracked in the state's PedNSS program, were exclusive breastfed, compared to the U.S. rate of 12.9% (KDHE, 2010). In 2010, Kansas WIC offices published results reported that 4,767 (14.9%) infants exclusively breastfed up to three months of age and 7, 876 (4%) infants exclusively breastfed up to six months of age (CDC, 2010b).

The Kansas PedNSS and PNSS programs received 100% of their data from state WIC offices. The demographics of the Kansas PedNSS population, as noted earlier, do not proportionately represent the U.S. population. According to the Kansas 2009 PedNSS population demographic report, the largest portion of Kansas families (47.9%) were white, over one-third (34.2%) were Hispanic, and the smallest portion (10.9%) were black. The U.S. Department of Commerce (2011) reported similar rankings (largest to smallest) of race and ethnic backgrounds in the U.S. population; however, the proportions were significantly different. Within the U.S. population, 72.4% were white, 16.3% were Hispanic, and 12.6% were black. Meanwhile, existing literature indicated that low-income and Hispanic children faced a higher risk for overweight and obesity. Therefore, the Kansas PedNSS represented a source of data with which to investigate the association between exclusive breastfeeding and childhood overweight and obesity in low-income and minority children.

This study used data from a sample of children that were followed in the Kansas PedNSS surveillance program from their birth in 2008 to until they turned three years of age in 2011. Therefore, to identify the sample for this study, four consecutive years of PedNSS data files were used. One year of PNSS files was needed to identify selected children's related maternal file.

Once the researcher received approval to access the requested Kansas PedNSS and PNSS data files, CDC examined all files and then shipped them on formatted compact discs. Data files were labeled by year (2008–2011) and saved in a .DAT file format, which opened with the Microsoft Excel 2010 program. Each file contained data on all children seen in Kansas WIC offices during that calendar year, not just those with birth dates in 2008. Using the PedNSS and PNSS record specifications manuals, an electronic code was written in 2010 Microsoft Excel and used to upload data into an IBM SPSS Statistics 20 program.

A series of steps was taken to identify those cases that met three fundamental inclusion criteria for this study, which are summarized in Figure 3. First, a filter variable (Filter I) was developed to identify all infants born in 2008. Then, applying the 2008 filter variable to the following three years of data files, a potential sample of 20,354 cases with 2008 birthdates (out of 79,557 cases) were identified. Next, each child case was linked to its mother's 2008 PNSS case file by matching unique alphanumeric identification codes and birth dates (Filter II). The 2008 PNSS file contained 20,703 individual cases, of which 18,737 were linked to one of the 20,354 child cases.

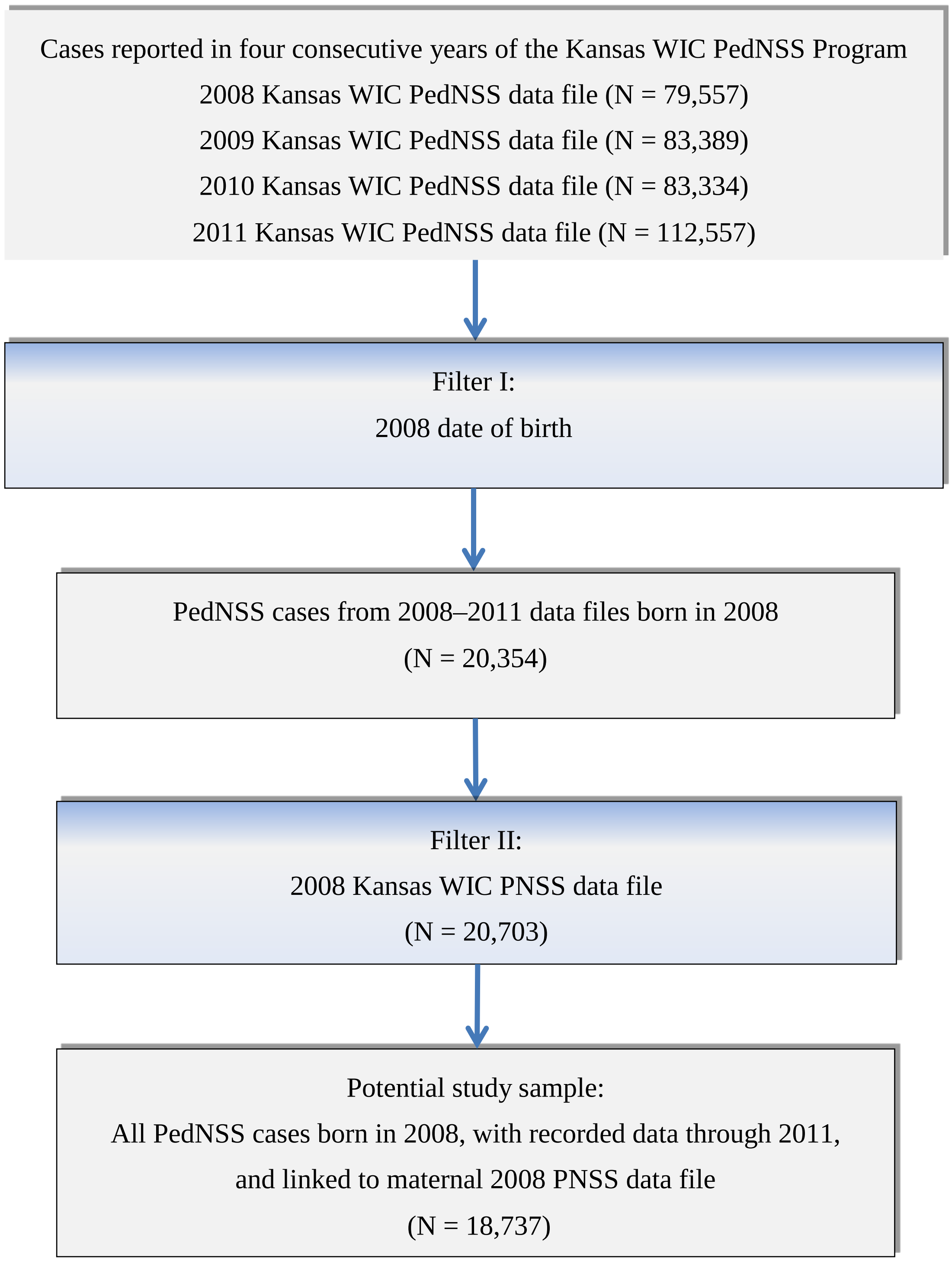

Figure 3. Identifying potential study sample

A third variable was designed to identify a study sample which had data recorded in the outcome variable field. The final filter variable (Filter III) was written to isolate cases with a recorded BMI percentile, BMI z-score, or height and weight measurements at three years of age. Of the 18,737 potential cases, 2,495 cases met this final criterion. Figure 4 represents the final process used to identify the study sample.

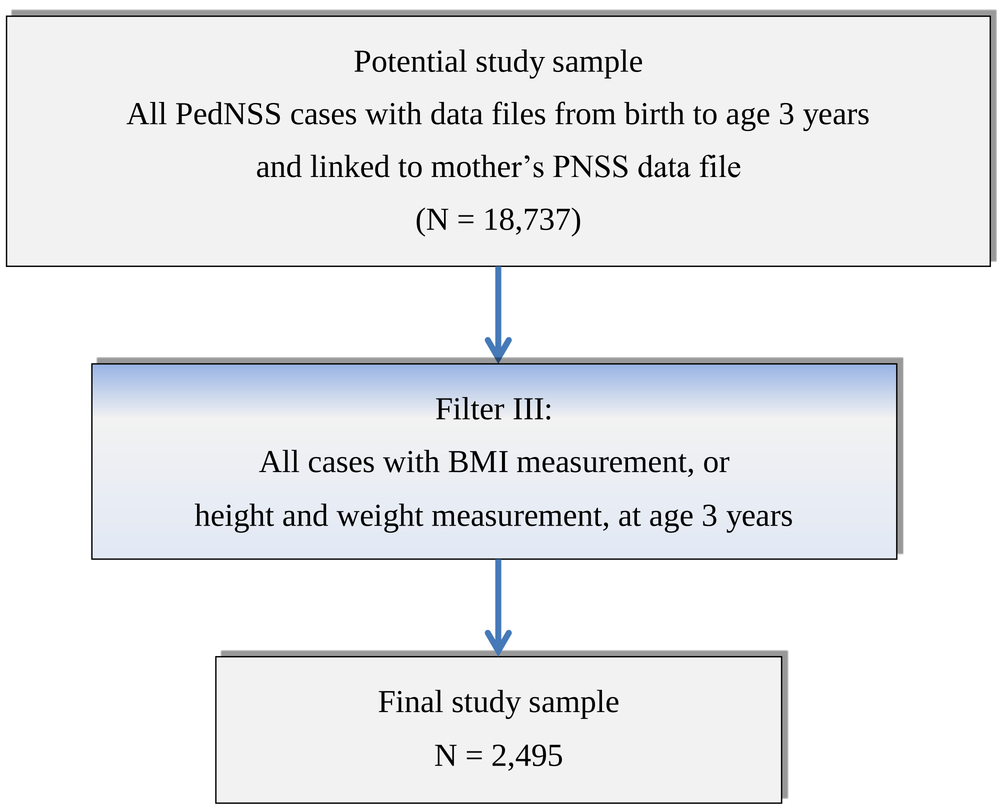

Figure 4. Identifying final study sample

The significant reduction in cases was similar to that reported in other studies that used these data sets. Grummer-Strawn and Mei (2004) used PNSS and PedNSS data from seven states that resulted in a final sample of 12,587 linked maternal-child cases that met the criteria of their study. Sharma, Cogswell, and Li (2008) began with 1,310,708 PNSS records and 2,178,566 PedNSS records. Their final study sample included 155,411 linked cases. Procter and Holcomb (2008) also used linked PNSS and PedNSS data. After they identified a cohort of 22,804 children born in1998, with data recorded through 2002, they then linked the child cases with their respective 1998 maternal PNSS data file. The final sample of linked cases in the Procter and Holcomb (2008) study was 3,692; however, their outcome variable was BMI-for-age percentile at 4 years of age.

The process used by Procter and Holcomb to identify a final analytic sample of linked cases provided the framework used to identify a study sample in this project. Application of the outcome variable of a BMI percentile, BMI z-score, or height and weight metric measurement at three years of age reduced the sample for this study below that in the Proctor and Holcomb (2008) study.

Sample size

Chapter 2 established the inconsistent and contradictory results reported in the literature regarding the effect of breastfeeding on reducing the risk for childhood obesity. Although the Kansas PedNSS and PNSS data provided a potentially large sample, the study sample (N = 2,495) proved smaller than anticipated. However, according to Cohen (1988), when using Chi-square (X^2) to determine whether differences exist between the analytic sample—or selected cases—and cases that do not meet the inclusion, as well as differences between subsets of the analytic sample, at least 130 cases are needed. When measuring the effect of independent variables (socio-economic, health-related factors, health behavior factors, and anthropometric measurements) on the dependent variable, a sample size needed to detect a medium effect required a different calculation. In a later publication, Cohen (1992) updated his guidelines and tables with calculated sample sizes for X^2 that are slightly different from the 1988 publication however confirm the study sample was more than sufficient.

The final analytic size (n= 1,452) for this study was not discernible until initial data analysis began. Based on previous studies that used linked PedNSS and PNSS data files, a potential sample of 2,000 to 3,000 cases were anticipated (Procter & Holcomb, 2008). However, exclusive breastfeeding rates were anticipated to reduce the sample further. According to the 2008 PedNSS report on infants participating in WIC, 62% were ever breastfed and 26.9% were breastfed for at least six months. In Kansas State WIC programs, 68% of infants were breastfed for some period and 20.6% were breastfed for at least six months (Polhamus, Dalenius, Mackentosh, Smith, & Grummer-Strawn, 2009).

Data management

Working with a consultant at George Mason University, the author constructed an electronic codebook based on the PedNSS and PNSS record specifications and descriptors. The code that was designed for reading the raw data into SPSS Statistics 20 software program included the type of variable (date, numeric, or string), the column(s) location on the Excel file, a name and label for each variable, data width including decimal positions, value labels and missing data values. After five to ten variables were read into the SPSS program, frequencies were conducted to check for accuracy. If an improbable value was noted, the electronic code was examined for error and corrected.

Syntax for reading, coding, labeling, and re-coding variables were saved with an annotated codebook describing the original and recoded variables. The original Excel workbook for each data file was saved, unaltered, in an electronic file. Next, after applying filter variables to identify a potential study sample, all cases of interest were saved and labeled as a new file. The potential sample file (N=18,737) and the final study sample file (N=2,495) were saved in separate file folders in preparation for data analysis. However, once the analytic sample (n=1,452) was identified, the cases remained in the same file along with the non-selected cases. To conduct the final analyses, the file was split to allow only selected cases to be entered into statistical calculations.

Over the course of six months, the iterative data management process resulted in a well-organized data set with variables that met the assumptions of the proposed research design and statistical analysis methods. The constructed data set was the platform on which the next phase of the study was built.

Measures

The next step in the research method was to examine the data and confirm measures of the proposed variables were congruent with conceptual definitions and field (operational) definitions discussed in Chapter I. Univariate tests revealed the distributions of selected variables as well as characteristics of the study sample. Frequencies with means, standard deviations, quartiles, and minimum and maximum values were used in the preliminary evaluation of the data measures, beginning with maternal factors.

Maternal age was measured in the number of years of age at the time of delivery. Frequencies conducted on maternal age informed the process of re-coding the continuous variable into a categorical variable with four age groups: less than 21 years of age, 21 to 25 years of age, 26 to 30 years of age, and older than 30 years of age. After recoding, frequencies were run on the new categorical variable to evaluate the distribution of ages in those four levels and then to assess its fit with the assumptions in bivariate and binary regression analyses. Results indicated the recoding created four levels with reasonable distribution of cases. Similar steps were taken in recoding other continuous variables into categorical variables, including pre-pregnancy BMI, the length of time an infant was breastfed, age in weeks of an infant when supplementary feeding was introduced, and child BMI percentiles, which will be discussed in detail later.

Before running univariate statistics to determine the distribution of race and ethnicity within the study sample, a number of steps were taken to create categories that reflect how race/ethnicity are reported in the literature. Based on the literature, a decision was made to create six major racial/ethnic categories: Hispanic, non-Hispanic-black, non-Hispanic-white, Asian, American Indian, and other. Hispanic ethnicity was coded separately from race (Grummer-Strawn & Mei, 2004; Ogden, Carroll, Kit, & Flegal, 2012; Taveras, Gillman, Kleinman, Rich-Edwards, & Rifas-Shiman, 2010). Therefore, to create a variable for non-Hispanic black, a code was written to identify all families who were black but not Hispanic.

The same was done for each race category recorded in the database. After successfully creating individual race/ethnicity variables, the frequencies revealed very few cases representing Asians and American Indians. Therefore, the next iteration of the race/ethnicity variable was a four-level categorical variable with Hispanic, non-Hispanic black, non-Hispanic white, and other. Eventually, the other category was removed because of extremely low numbers, which would have weakened the analysis.

Maternal education was initially coded as a continuous variable. The mean and standard deviation indicated very few cases that had completed less than nine years of education. Sharma, Cogswell, and Li (2008) conducted a study using the same source of data and recoded maternal education into three levels of education: less than high school, high school, and more than high school. Sing, Siahpush, Hiatt, and Timsina (2010) used a similar construct for measures of maternal education. Therefore, a new variable with three levels of education produced a categorical variable with balanced distributions between the three levels: completed less than 12 years, completed 12 years, and completed more than 12 years of education.

Maternal health history and behavior factors included pre-pregnancy BMI, gestational diabetes, smoking history, and prenatal care initiation. Transforming the continuous pre-pregnancy BMI variable into a categorical variable was based on the CDC standards for adult female BMI measures. These standards are also reported in the literature (Procter & Holcomb, 2008). However, subsequent analysis revealed the underweight category produced cells with very few cases and therefore the underweight classification and associated cases were removed. Additional bivariate tests for association revealed that grouping the overweight/obese cases into one category enhanced the power of the analysis. Therefore, the final variable had two categories: normal BMI and overweight/obese BMI.

Gestational diabetes was originally recorded as a dichotomous variable in the PNSS data files and thus it did not need any further attention. However, smoking history required significant manipulation. History of smoking was measured at three months prior to gestation, at time of prenatal visit, during last three months of pregnancy, and at post-partum visit. Because few cases had recorded history of smoking during all four periods, a decision was made to group cases from all four variables into one yes/no-dichotomous variable of history of smoking. Mothers, who reported smoking during any of the times surveyed, were placed into the *yes* category, and those who never smoked were placed in the *no* category. Kitsantas and Gaffney (2010) also used a yes/no-dichotomous variable in their study that examined risk profiles for overweight/obesity among preschoolers.

Prenatal care initiation was originally coded as a categorical variable with four levels of care. Again, univariate and bivariate analyses revealed very low numbers in three of the four levels, which also translated into cells with few or no cases when chi-square for association tests were run. Therefore, to fit the assumptions for chi-square analysis, and to strengthen the power of the analysis, the four-level variable was transformed into a dichotomous variable. The literature reported standards for women's preconception and prenatal care. Evidence-based standards recommend early prenatal care, which was defined care that begins within the first trimester (Moos et al. 2008).

Therefore, all cases that accessed prenatal care within the first trimester were placed in the *timely* level, while all other cases that accessed care after the first trimester and those who reported no prenatal care, were included in the *untimely* level of the new variable.

Child variables required similar treatments. Cases with a valid entry between 35 and 37 months were coded as a three-year old. Similarly, cases with a valid entry between 23 and 25 months were coded as a two-year old. The frequencies returned only 745 cases with anthropometric measurements recorded at age two, which was less than a third of those with data at three years of age. Including the two-year old BMI percentiles would significantly reduce the potential analytic sample and therefore this variable was not included in the regression analysis.

While gender and gestational age were straightforward categorical variables that fit well into the study design, other variables needed further manipulation. For example, the birth weight variable was first recoded from its original continuous scale into a variable that reflected standard definitions and was used in the PedNSS and PNSS programs (CDC, 2009). Frequencies revealed few cases in the very low birth weight category and therefore these cases were removed.

Child anthropometrics (BMI percentiles) were also categorized according to the 2000 CDC growth charts and definitions; underweight $< 5\%$; normal weight (5% – 84%); overweight (85% – 94%) and obese ($\geq$ 95%). Again, the low number of cases in the underweight category prompted the decision to remove those cases. The three remaining categories were eventually grouped into two dichotomous values for use as the outcome variable.

Breastfeeding related variables included: (1) if a child was ever breastfed (yes, no), (2) the length of time the child was breastfed (weeks), and (3) the child's age in weeks when first supplemental feedings were begun. Only infants who were ever breastfed were included in the length of time breastfed and supplemental feeding variables. These three variables were used to create two additional variables that would represent breastfeeding duration within the first six months of life, as well as the duration of exclusive breastfeeding.

Frequencies were run to examine the proportion of infants who were ever breastfed in the sample and then the distribution of time that breastfed infants continued nursing. Based on the frequencies, two categorical variables were created to determine which provided the best representation of the distributions as well as provided sufficient cases in the different categories. The best fit for this sample was to code the length of time an infant was breastfed into four time intervals: less than one month, one to two months, three to five months, and six months of age and longer. This variable was labeled *breastfeeding history*. Next, cases that were coded as never breastfed were also added to the *breastfeeding history* variable, by creating a fifth category, labeled *never breastfed*. The final, five-category variable represented all infant cases within the study sample.

As mentioned in Chapter I (page 25), exclusive breastfeeding is defined as an infant's consumption of human milk with no supplementation of any type including infant formula, cow's milk, juice, sugar water, baby food and anything else, even water. Vitamins, minerals and medications were not included in the definition of supplemental feedings. The PedNSS program uses the time at which supplemental feeding was introduced, to determine duration of exclusive breastfeeding since this variable only applied to infants who were ever breastfed. The same process was used for this project.

Since age (in weeks) at which supplemental feeding was introduced applied only to breastfed infants, this measure was used to create an exclusive breastfeeding variable.. For example, if an infant was breastfeeding at four weeks of age, and a supplemental feeding was first introduced during the fourth week of age, then that infant was identified as exclusively breastfed for three weeks. Another infant who was also breastfeeding at four weeks, but supplemental feedings were not introduced until the fifth week of age, then that infant was categorized as exclusively breastfed for four weeks.

After the code was applied, the resulting variable grouped exclusively breastfed infants into five categories. The first category was *never exclusively breastfed,* which represented those breastfed infants who received supplemental feedings within the first week. The remaining categories measured duration of exclusive breastfeeding in four intervals: less than one month, one to two months, three to five months, and six months and longer.

Data analyses

Selected methods of analyses for measuring the effect of exclusive breastfeeding on the risk for overweight/obesity required an evidenced-based process of recoding certain variables. A number required recoding from continuous to categorical level measures. Others were originally coded in two separate fields (e.g. race and ethnicity) and then combined to create one variable. Dates were essential components of the analyses and were coded to facilitate the process. For example, the child's date of birth was recoded so the year of birth could be used for identifying a sample of cases with a 2008 date of birth. The results were a set of data appropriate for the planned analyses.

A summary of data analysis methods are displayed in Table 3. The first level of analysis described the frequency and distribution of all variables within the study sample. Sociodemographic features included maternal age, education level, and race/ethnicity. Maternal health history and behavior factors included prepregnancy BMI, gestational diabetes, smoking history, and the timing of prenatal care initiation. Infant/child independent factors include gender, birth weight, gestational age at birth, history of ever being breastfed, duration of breastfeeding, age when supplemental feeding was introduced, and the length of time the child was exclusively breastfed. Children included in the study had birth weight plus a recorded BMI percentile- for age and sex, at three years of age.

The second level of analysis explored the associations between the main independent variable (exclusive breastfeeding), covariates, and the outcome variable (BMI percentile at age three). Bivariate analysis was also used to measure statistically significant differences between the final analytic sample cases and sample cases not included in the final analyses. Binary logistic regression modeling measured both the direct effect of exclusive breastfeeding duration on the risk for overweight/obesity at three years of age, as well as the effect of exclusive breastfeeding duration on risk for overweight/obesity when controlled for other contributing factors (covariates).

Table 3. Data analysis plan

Level of analysis	Statistical method	Variables and format
Univariate	Frequencies, means and standard deviations (SD)	Continuous and categorical IV, CVs and DV
Bivariate	Chi- square test for association between IV, CVs and DV, and variance between samples	Categorical IV, CVs and DV
Inferential	Logistic regression	Categorical IV, CVs and DV

Ethical considerations

The research study proposes a clinically significant question based on the current state of the science and designed within a sound theoretical framework. A retrospective, secondary data analysis design represents low risk to the individuals or group included in the data set. The unique, alphanumeric identification code assigned to each case file in this data set protects the individuals' anonymity. In addition, the key to the code remains with the contributing agency, therefore this author in unable to identify any individual in the data files used in this project. George Mason University's Office of Research Subject Protections determined that this project fell under the Department of Health and Human Services (DHHS) Exempt Category 4, and thus conducted an expedited review process. Approval to proceed with the proposed study was granted in May 2012. A copy of the approval is found in Appendix II.

Summary

This chapter discussed the design and methods used to examine the relationship between exclusive breastfeeding and a risk for overweight/obesity at three years of age. Specifically, the purpose of this study is to examine a possible dose-related effect of exclusive breastfeeding on the risk of childhood overweight and obesity at three years of age in a cohort of children followed from birth to three years of age. The use of a current, longitudinal child data set that was linked to maternal prenatal health records, and collected detailed breastfeeding data, provided a significant resource with which to conduct this study. The results of statistical analyses are detailed in Chapter Four, which inform the discussion and recommendations in Chapter Five.

CHAPTER FOUR: RESULTS OF ANALYSES

Introduction

A series of statistical analyses was conducted to examine the relationship between the length of exclusive breastfeeding and a risk for overweight/obesity at three years of age. Cases included in the initial study sample (N= 2,495) were derived from linked datasets provided by the Kansas state Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) and reported in their annual Pregnancy and Pediatric Nutrition Surveillance System programs (PNSS and PedNSS). These data were collected between 2008 and 2011 and managed by the Centers for Disease Control and Prevention (CDC).

This chapter reports the results of univariate, bivariate, and inferential statistical analyses that were used to explore three research questions. The chapter begins with the distributions of characteristics within the study sample, which provides a composite profile of the study sample. Next, bivariate analyses identified associations between the main independent variable (duration of exclusive breastfeeding), known covariates, and the outcome variable (overweight/obesity BMI percentile at three-years-of age). Finally, binary logistic regression calculated the likelihood of risk for overweight/obesity at three years of age, given different lengths of time of exclusive breastfeeding, and while controlling for other associated factors.

Study sample distributions

Maternal characteristics. Table 4 details the means, standard deviations, and percentages of maternal variables in the study sample. In general, this sample was under 26 years of age, with a Hispanic or non-Hispanic white racial/ethnic background, and had the equivalence of a high school education. Specifically, mothers in the study sample ranged in age from 14 to 43 years (M=24.9, SD=24.9). The largest percentage (59.1%) of mothers was younger than 26-years of age; however, 55% were between the age of 21 and 30 years old and the smallest percentage (18%) were older than 30 years of age. Over sixty percent (61.5%) of mothers completed at least twelve years of education, 22% reported completing additional years of education beyond high school, while more than a third (38.7%) did not complete 12 years of education. The largest race/ethnic group (50.6%) was non-Hispanic whites, followed by Hispanic (36%), and non-Hispanic black (9.8%). The remaining 3.6% were those who were grouped in the *other* category.

Overall, the distribution of variables measuring maternal health history and behaviors revealed a significant percentage of mothers with healthy backgrounds. Almost three quarters (74.9%) of these mothers, accessed prenatal care within the first trimester, never smoked (74.5%), and most (97.8%) did not have gestational diabetes during this pregnancy. However, the results also indicated that approximately one out of four had a history of smoking. Further, pre-pregnancy body mass index (BMI) distributions revealed that just over 23% of mothers were overweight and 32% were obese.

In comparison, maternal cases not included in this study sample were slightly younger with only 12.9% older than 30 years of age, had a similarly low incidence

(3.9%) of gestational diabetes, and a slightly higher rate of completing at least 12 years of education (67.7%). The same three race/ethnic groups were distributed in a similar pattern with a slightly higher percentage of non-Hispanic White (58.6%), a lower percentage of Hispanic (26.4%), and slightly larger group of non-Hispanic black (11.7%). Maternal health history and behaviors were similar except for a slightly higher rate of smoking (31.9%).

Table 4. Distributions of maternal characteristics in original study sample

	Mean (SD)	N (%)	Missing N (%)
Maternal Demographics			
Age (years)	24.9 (5.9)	2,495 (100)	2,495 (0%)
< 21		658 (26.4)	
21 - 25		816 (32.7)	
26 - 30		563 (22.6)	
> 30		458 (18.3)	
Race/ethnicity		2,495 (100)	2,495 (0%)
Hispanic		897 (36.0)	
Non-Hispanic black		245 (9.8)	
Non-Hispanic white		1,262 (50.6)	
Other		91 (3.6)	
Education (years)	11.27 (2.5)	2,300 (92.2)	195 (7.8)
< 12		889 (38.7)	
12		895 (38.9)	
> 12		516 (22.4)	
Health history			
Pre-pregnancy BMI	27.5 (7.2)	2,483 (99.5)	12 (0.5)
Under weight (< 18.5)		96 (4.0)	
Normal (18.5 – 24.9)		977 (40.7)	
Overweight (25.0 – 29.9)		564 (23.4)	
Obese (≥ 30.0)		766 (31.9)	
Gestational Diabetes		2,367 (94.9)	128 (5.1)
No			
Yes			
Health behavior			
Smoking History		1,867 (74.8)	628 (25.2)
No		1,391 (74.5)	
Yes		476 (25.5)	

Table 4 (cont.)	**Mean (SD)**	**N (%)**	**Missing N (%)**
Prenatal care initiation		2,379 (95.4)	116 (4.6)
1st trimester		1,783 (74.9)	
2nd trimester		401 (16.9)	
3rd trimester		45 (1.9)	
No care		150 (6.3)	

Child characteristics. Table 5 includes the means, standard deviations, and percentages of child variable distributions in this study sample. Children in the study sample were born between January 1 and December 31, 2008. Gender was divided relatively evenly, with a slightly higher percentage of males (51%) compared to females (49%). More than 80% of the children were born between 37 to 40 weeks of age and weighed between 2,500 to 4,000 grams at birth. However, 11% children were born after 40 weeks' gestation and 10% weighed greater than 4,000 grams at birth.

Close to 70% of infants were breastfed for some time. The calculated mean duration of breastfeeding was approximately 16 weeks (M=15.5, SD =19.0) or just under four months. Note the large standard deviation, which represents a wide variation in duration of breastfeeding within this sample. When recoded into months, the descriptive analysis revealed almost 43% of infants were no longer breastfed after one month of age and by six months, less than a quarter (23.9%) continued breastfeeding.

Supplemental feedings were introduced, on average, before four-weeks-of-age (M=3.4, SD=6.8) in this study sample. More than three-quarters (75.5%) of breastfed infants received a supplemental feeding before one month of age, and by two months approximately 84% of all breastfed infants had received supplemental feedings. Exclusive breastfeeding cases were identified by using the timing of introduction of supplemental feeding in breastfed infants. Univariate results indicated that 41% of breastfed infants were exclusively breastfed for at least three weeks, however only 16% of infants in this sample were exclusively breastfed longer than two months.

Only 30% of this study sample had recorded anthropometric measurements at or around their two-year birthday. Within this two-year-old group, less than two percent fell into the underweight category, yet 23.7% had a BMI percentile that placed them in the overweight or obese categories in reference to the CDC's 2000 growth charts for age and gender. Data for BMI percentile at age two were not included in the final analysis because of the low number of cases. The outcome variable for this study was the child's BMI percentile for age and gender at three years of age. Only children with a BMI percentile measured between 35 and 37 months of age (n=2,495) were included in this study. In this age group, 29.2 % were overweight/obese.

Table 5. Distributions of child characteristics in original study sample

	Mean (SD)	N (%)	Missing N (%)
Child Characteristics			
Gender		2,495 (100.0)	2,495 (0%)
Female		1,222 (49.0)	
Male		1,273 (51.0)	
Health history factors			
Birth weight (grams)	3267.1 (559.0)	2,495 (100)	2,495 (0%)
LBW (< 2500)		170 (6.8)	
NBW (2500 – 4000)		2,075 (83.2)	
HBW (> 4000)		250 (10.0)	
Gestational age (weeks)	38.9 (2.1)	2,118 (84.9)	377 (15.1)
< 37		159 (7.5)	
37 to 40		1,732 (81.4)	
> 40		236 (11.1)	
History ever breastfed		2,313 (92.7)	182 (7.3)
Yes		1,610 (69.6)	
No		703 (30.4)	
Breastfeeding history	15.5 (19.0) weeks	2,313 (92.7)	182 (7.3)
Never breastfed		697 (30.1)	
< 1 month		539 (23.3)	
1 - 2 months		310 (13.4)	
3 - 5 months		325 (14.1)	
≥ 6 months		442 (19.1)	
Age supplemental feeding introduced	3.4 (6.8) weeks	1,779 (71.3)	716 (28.7)
< 1 month		1,343 (75.5)	
1 - 2 months		157 (8.8)	
3 - 5 months		181 (10.2)	
≥ 6 months		98 (5.5)	

Table 5 (cont.)			
	Mean (SD)	**N (%)**	**Missing N (%)**
Exclusively breastfed (months)		1,779 (71.3)	716 (28.7)
No		1,038 (58.3)	
< 1		386 (21.7)	
1 - 2		116 (6.6)	
3 - 5		160 (9.0)	
≥ 6		79 (4.4)	
Child Anthropometrics			
BMI percentiles at 2 yo		754 (30.2)	1,741 (69.8)
Underweight (< 5)		14 (1.9)	
Normal (5 to 84)		474 (62.8)	
Overweight (85 to 94)		141 (18.7)	
Obese (≥ 95)		125 (16.6)	
BMI percentiles at 3 yo		2,495 (100)	2,495 (0%)
Underweight (< 5)		101 (4.0)	
Normal (5 to 84)		1,666 (68.8)	
Overweight (85 to 94)		359 (14.4)	
Obese (≥ 95)		369 (14.8)	

Bivariate associations

Maternal characteristics. Bivariate associations between maternal characteristics and child BMI percentiles at age three years were calculated using chi-square analyses. Table 6 displays the percent distributions between the outcome variable and each independent variable, as well as the chi-square (χ^2) statistic and significance (*p*). Gestational diabetes was eliminated from the next level of analysis because of the extremely small number of cases (2.2%) who reported a diagnosis during this pregnancy. Six maternal characteristics were tested for association with each of the four BMI percentile categories (underweight, normal, overweight, and obese).

The results indicated that three of the six maternal characteristics demonstrated a statistically significant association with the outcome variable. Although the literature reported smoking as an associated factor, it was not evident in this sample. The results also indicated no statistically significant association with maternal age *(p* = .108) or the timing of prenatal care initiation (*p* = .434). In evaluating the statistically significant association between race/ethnicity and the four BMI percentile categories at three years of age (χ^2= 25.36(9), *p* =.003), the largest number of cases from each race/ethnicity category was associated with the normal weight BMI percentile category. Although Hispanics represent 36% of mothers in this sample, they represent the largest group (45.3%) in the obese BMI percentile category compared to the non-Hispanic whites (42.8%) and non-Hispanic blacks (7.6%).

An even stronger association was measured between maternal prepregnancy BMI and children's BMI percentile at three years of age (χ^2= 68.54(9), *p* = .000). The distribution indicates that three-year-old children who were overweight/obese were more likely to have been born to overweight/obese mothers, based on the mother's prepregnancy BMI. Maternal level of education was significantly associated with the child's BMI at 3 years of age (χ^2 =12.68(6), *p*= .048). Children, whose mothers had fewer than 12 years of education, were more likely to be overweight/obese at age three. Overall, significant associations were observed between children's overweight/obesity and maternal education that was than 12 years, a prepregnancy BMI $\geq$ 30, and Hispanic ethnicity.

Table 6. Bivariate associations: maternal characteristics and outcome variable

	Underweight % n (%)	Normal weight % n (%)	Overweight % n (%)	Obese % n (%)	χ^2	*p*
Maternal Demographics						
Age (years)					14.42	.108
< 21	28 (27.7)	461 (27.7)	75 (20.9)	94 (25.5)		
21 - 25	33 (32.7)	546 (32.8)	130 (36.2)	107 (29.0)		
26 - 30	27 (26.7)	361 (21.7)	87 (24.2)	88 (23.8)		
> 30	13 (12.9)	298 (17.8)	67 (18.7)	80 (21.7)		
Race/ethnicity					25.36	.003
Hispanic	32 (31.7)	537 (34.4)	125 (34.8)	167 (45.3)		
Non-Hispanic black	13 (12.9)	173 (10.4)	31 (8.6)	28 (7.6)		
Non-Hispanic white	53 (52.5)	854 (51.3)	197 (54.9)	158 (42.8)		
Other	3 (2.9)	66 (4.0)	6 (1.7)	16 (4.3)		
Education (years)					12.68	.048
< 12	34 (37.0)	577 (37.9)	119 (35.0)	159 (46.2)		
12	36 (39.1)	592 (38.8)	141 (41.5)	126 (36.6)		
> 12	22 (23.9)	355 (23.3)	80 (23.5)	59 (17.2)		
Health history						
Pre-pregnancy BMI					68.54	.000
Underweight	6 (6.0)	76 (4.7)	7 (2.0)	7 (2.0)		
Normal	51 (52.0)	702 (43.7)	128 (36.7)	96 (27.5)		
Overweight	20 (20.4)	376 (23.4)	80 (22.9)	88 (25.2)		
Obese	21 (21.4)	453 (28.2)	134 (38.4)	158 (45.3)		

Table 6 (cont.)

	Underweight % n (%)	**Normal weight % n (%)**	**Overweight % n (%)**	**Obese % n (%)**	χ^2	p
Health behaviors						
Smoking History					1.71	.634
No	59 (77.6)	916 (74.4)	201 (72.3)	215 (76.5)		
Yes	17 (22.4)	316 (25.6)	77 (27.7)	66 (23.5)		
Prenatal care initiation					9.04	.434
1st Trimester	73 (76.8)	1,175 (73.8)	260 (76.5)	275 (77.9)		
2nd Trimester	17 (17.9)	273 (17.2)	60 (17.6)	51 (14.4)		
3rd Trimester	0 (0.0)	32 (2.0)	7 (2.1)	6 (1.7)		
No Care	5 (5.3)	111 (7.0)	13 (3.8)	21 (6.0)		

Child characteristics. Eight child characteristics (see Table 7) were included in the bivariate analyses. Four characteristics had statistically significant chi-square values. No significant association was measured between the child's gender, gestational age, ever breastfed, or history of breastfeeding, and the outcome variable.

A child's weight at birth (χ^2 = 32.2 (6), *p*= .000) was found to be strongly associated with a child's BMI percentile at three years of age. A significant percentage of children (21%) who weighed more than 4,000 grams at birth were associated with obesity at age three. In contrast, 14% of children with normal birth weight were associated with obesity at three years of age.

The age at which supplemental feedings were introduced was also statistically significant (χ^2 = 22.31(9), *p* = .008). Among ever breastfed children, of those who received supplemental feeding before one month of age, 31% were likely be overweight or obese at three years old. When supplemental feedings were introduced later, breastfed children were less likely to be overweight or obese. When supplemental feedings were introduced between one to two months of age, 19% of children were overweight and obese at three years old. Even fewer (17%) children were likely to be obese or overweight when supplemental feedings were delayed until six months. The statistically significant association between exclusive breastfeeding and the child BMI percentile at three years old (χ^2 = 32.86 (12), *p* =.001) was similarly strong. Infants who were exclusively breastfed for the longest time were less likely to be overweight/obese at three years of age.

Finally, a greater percentage of two year old children who were overweight or obese were associated with overweight/obesity at three years of age (χ^2 = 452.67(9), *p*= .000), compared to children who had a normal BMI percentile at age two years. Bivariate results indicate a child's overweight/obesity at three years of age is associated with a birth weight greater than 4,000 grams, early introduction of supplementary feedings, not exclusively breastfed, and being overweight/obese at two years of age.

Table 7. Bivariate associations: child characteristics and outcome variable

	Underweight % n (%)	Normal weight % n (%)	Overweight % n (%)	Obese % n (%)	χ^2	*p*
Child Characteristics						
Gender					3.24	.356
Female	55 (54.5)	851 (51.1)	170 (47.4)	197 (53.4)		
Male	46 (45.5)	815 (48.9)	189 (52.6)	172 (46.6)		
Health history factors						
Birth weight (grams)					32.2	.000
LBW (< 2500)	17 (16.8)	101 (6.1)	22 (6.1)	30 (8.1)		
NBW (2500 to 4000)	76 (75.2)	1,420 (85.2)	292 (81.3)	287 (77.8)		
HBW (> 4000)	8 (8.0)	145 (8.7)	45 (12.6)	52 (14.1)		
Gestational age (weeks)					3.71	.716
< 37	9 (10.7)	97 (6.9)	26 (8.3)	27 (8.4)		
37 - 40	66 (78.6)	1,150 (82.3)	253 (80.6)	254 (78.9)		
> 40	9 (10.7)	151 (10.8)	35 (11.1)	41 (12.7)		
History ever breastfed					1.68	.642
Yes	64 (72.7)	1,087 (70.5)	226 (67.9)	239 (68.3)		
No	24 (27.3)	455 (29.5)	107 (32.1)	111 (31.7)		

Table 7 (cont.)

	Underweight % **n (%)**	**Normal weight %** **n (%)**	**Overweight %** **n (%)**	**Obese %** **n (%)**	χ^2	*p*
Breastfeeding history (months)					14.55	.267
Never breastfed	24 (27.3)	455 (29.5)	107 (32.1)	111 (31.7)		
< 1	23 (26.1)	360 (23.3)	64 (19.2)	92 (26.3)		
1 - 2	13 (14.8)	200 (13.0)	46 (13.8)	51 (14.6)		
3 - 5	13 (14.8)	210 (13.6)	56 (16.8)	46 (13.1)		
$\geq$ 6	15 (17.0)	317 (20.6)	60 (18.1)	50 (14.3)		
Age supplemental feeding introduced (months)					22.31	.008
< 1	55 (72.4)	873 (73.4)	192 (76.2)	223 (85.4)		
1 - 2	5 (6.6)	112 (9.4)	21 (8.3)	19 (7.3)		
3 - 5	9 (11.8)	131 (11.0)	27 (10.7)	14 (5.4)		
$\geq$ 6	7 (9.2)	74 (6.2)	12 (4.8)	5 (1.9)		
Exclusively breastfed (months)					32.86	.001
No	43 (56.6)	664 (55.8)	148 (58.7)	183 (70.1)		
< 1	12 (15.8)	265 (22.3)	58 (23.0)	51 (19.5)		
1 - 2	8 (10.5)	82 (6.9)	13 (5.2)	13 (5.0)		
3 - 5	6 (7.9)	121 (10.2)	22 (8.7)	11 (4.2)		
$\geq$ 6	7 (9.2)	58 (4.8)	11 (4.4)	3 (1.2)		
Child anthropometrics						
BMI percentiles at 2 years					452.67	.000
Underweight (< 5)	8 (30.8)	6 (1.1)	0 (0.0)	0 (0.0)		
Normal (5 - 84)	18 (69.2)	418 (79.8)	29 (31.2)	9 (8.1)		
Overweight (85 - 94)	0 (0.0)	69 (13.2)	40 (43.0)	32 (28.8)		
Obese ($\geq$ 95)	0 (0.0)	31 (5.9)	24 (25.8)	70 (63.1)		

Table 7 (cont.)

	Underweight % **n (%)**	**Normal weight %** **n (%)**	**Overweight %** **n (%)**	**Obese %** **n (%)**	χ^2	*p*
Child anthropometrics						
BMI percentiles at 2 years					452.67	.000
Underweight (< 5)	8 (30.8)	6 (1.1)	0 (0.0)	0 (0.0)		
Normal (5 - 84)	18 (69.2)	418 (79.8)	29 (31.2)	9 (8.1)		
Overweight (85 - 94)	0 (0.0)	69 (13.2)	40 (43.0)	32 (28.8)		
Obese ($\geq$ 95)	0 (0.0)	31 (5.9)	24 (25.8)	70 (63.1)		

Revised analysis based on findings from study sample

The bivariate analyses revealed that a number of variables had low number of cell cases (e.g. 0, 5) and some were not significantly associated with the outcome variable. Variables with low number of cell cases were recoded to increase the number of cases per cell. Within the maternal characteristics, race/ethnicity was recoded to identify only those cases, which belonged to the three largest categories: Hispanic, non-Hispanic black, and non-Hispanic white; therefore cases, which belonged in the other category, were excluded from further analyses. The prepregnancy BMI was also recoded to include only cases that belonged in the normal (18.5 to 24.9), overweight (25.0 to 29.9), and obese (> 30) BMI categories. .

Prenatal care was recoded into two categories to enhance the power of this variable by grouping together all cases outside the standard definition of timely initiation of prenatal care. Timely initiation of prenatal care included only mothers who accessed prenatal care within the first trimester, while untimely initiation of prenatal care included cases that did not access care until the second trimester, third trimester, or reported not receiving any prenatal care.

Two child variables were also recoded. Cases in the underweight BMI percentile at two years of age and three years of age were removed due to the extremely low numbers in this category. The next iteration of the BMI percentile for two-year-olds and three-year-olds had three categories. The categories included normal (5 to 84), overweight (85 to 94), and obese BMI ($\geq$ 95) percentiles.

Recoding the above-mentioned variables resulted in the loss of 101 cases from the original study sample, leaving 2,394 cases for use in the next phase of analysis. Bivariate associations between maternal characteristics and child BMI percentiles at three years of age were again measured using chi-square analysis. Results of these analyses are detailed in Tables 8 and 9. They reveal associations similar to those observed in the first bivariate chi-square analysis.

Again, maternal race/ethnicity, education level, and pre-pregnancy BMI remained strongly associated with the dependent variable. However, maternal age and smoking history continued to lack statistically significant associations in this sample. Recoding the timing of prenatal care initiation also did not result in statistically significant measurement of the association with the dependent variable.

The statistical significance of maternal education (χ^2 = 12.51(4), p = .014) proved to be stronger than in the previous test (χ^2 = 12.68 (6), p = .048). Distribution of cases revealed that 33% of mothers with less than 12 years of education were more likely to have a child with a BMI in overweight/obese percentile at three years of age, compared to mothers who completed 12 years of education (31%). Mothers with more than 12 years of education were the least likely (28%) to have a three-year-old with a BMI in the overweight/obesity BMI percentiles.

Review of the case distributions in maternal race/ethnicity cells, showed that 35% of Hispanic mothers had a child with overweight/obese BMI percentiles, compared to 30% of non-Hispanic white mothers, and 12% of non-Hispanic black mothers whose child's BMI was in the overweight/obese category. However, when considering only the overweight BMI percentile cells, 16% of non-Hispanic white mothers were associated with this category compared to 14% of Hispanic mothers, and 13% of non-Hispanic black mothers.

Child characteristics also retained similar levels of association with the outcome variable as seen in the initial chi-square analysis. In this sample, gender, gestational age plus history of ever having been breastfed as well as the duration of breastfeeding did not have a statistically significant association with the outcome variable. As noted previously, birth weight, the age at which supplemental feedings were introduced, the duration of exclusive breastfeeding, and BMI percentile at two-years-old, demonstrated a significant association with overweight/obese level BMI percentiles at three years of age.

Again, the distribution of birth weight within the outcome variable cells (χ^2 = 15.45(4), *p*=.004), revealed that infants with birth weights greater than 4,000 grams were more likely to be overweight or obese at three years of age. Specifically, 19% of these infants were likely to be in the overweight BMI percentile category at three years of age, compared to infants with normal birth weight (15%), and infants with low birth weight (14%). Similarly, 21% of infants with high birth weight were likely to be in the obese BMI percentile at three years of age, compared to 14% of infants with normal weight. Of note, is that 19% of infants with low birth weight were likely to be in the obese BMI percentile at three years old, which was slightly higher than observed in the infants with normal weight.

In summary, the recoding of variables met the assumptions for chi-square analysis and did not change the statistical significance of associations measured in the first chi-square test. Therefore, the bivariate test for association revealed characteristics within this study sample that contribute to the risk of a child being in the overweight/obese BMI percentile range at three years of age. This level of analysis also informed the next step of exploring the relationship between length of exclusive breastfeeding and risk for overweight/obesity at three years of age

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Table 8. Bivariate associations: revised maternal variables and outcome variable

	Normal weight %	Overweight %	Obese %	χ^2	*p*
Demographics					
Age (years)				11.80	.067
< 21	461 (27.6)	75 (20.9)	94 (25.5)		
21 - 25	546 (32.8)	130 (36.2)	107 (29.0)		
26 - 30	361 (21.7)	87 (24.2)	88 (23.8)		
> 30	298(17.9)	67 (18.7)	80 (21.7)		
Race/ethnicity				18.74	.001
Hispanic	537 (35.8)	125 (35.4)	167 (47.3)		
Non-Hispanic black	173 (10.8)	31 (8.8)	28 (7.9)		
Non-Hispanic white	854 (53.4)	197 (55.8)	158 (44.8)		
Education (years)				12.51	.014
< 12	577 (37.9)	119 (35.0)	159 (46.2)		
12	592 (38.8)	141 (41.5)	126 (36.6)		
> 12	355 (23.3)	80 (23.5)	59 (17.2)		
Health history					
Pre-pregnancy BMI				50.01	.000
Normal	702 (45.9)	128 (37.4)	96 (28.1)		
Overweight	376 (24.6)	80 (23.4)	88 (25.7)		
Obese	453 (29.6)	134 (39.2)	158 (46.2)		

Table 8 (cont.)

	Normal weight %	**Overweight %**	**Obese %**	χ^2	p
Health behaviors					
Smoking History				1.30	.522
No	916 (74.4)	201 (72.3)	215 (76.5)		
Yes	316 (25.6)	77 (27.7)	66 (23.5)		
Prenatal care initiation				3.06	.216
Timely start	1,175 (73.9)	260 (76.5)	275 (77.9)		
Untimely start	416 (26.1)	80 (23.5)	78 (22.1)		

Table 9. Bivariate associations: revised child variables and outcome variable

	Normal weight %	Overweight %	Obese %	χ^2	*p*
Child Characteristics					
Gender				2.74	.254
Female	851 (51.1)	170 (47.4)	197 (53.4)		
Male	815 (48.9)	189 (52.6)	172 (46.6)		
Health history					
Birth weight				15.45	.004
LBW	101 (6.1)	22 (6.1)	30 (8.1)		
NBW	1,420 (85.2)	292 (81.3)	287 (77.8)		
HBW	145 (8.7)	45 (12.6)	52 (14.1)		
Gestational age (wks)				2.43	.657
< 37	97 (6.9)	26 (8.3)	27 (8.4)		
37 - 40	1,150 (82.3)	253 (80.6)	254 (78.9)		
> 40	151 (10.8)	35 (11.1)	41 (12.7)		
Ever breastfed				.584	.747
Yes	1,079 (70.0)	227 (68.2)	240 (68.6)		
No	463 (30.0)	106 (31.8)	110 (31.4)		

Table 9 (cont.)

	Normal weight %	Overweight %	Obese %	χ^2	*p*
Breastfeeding history (months)				3.612	.092
Never breastfed	455 (29.5)	107 (32.1)	111 (31.7)		
< 1	360 (23.3)	64 (19.2)	92 (26.3)		
1 - 2	20 (13.0)	46 (13.8)	51 (14.6)		
3 - 5	210 (13.6)	56 (16.8)	46 (13.1)		
≥ 6	317 (20.6)	60 (18.1)	50 (14.3)		
Age supplemental feeding introduced (months)				19.81	.003
< 1	873 (73.4)	192 (76.2)	223 (85.4)		
1 - 2	112 (9.4)	21 (8.3)	19 (7.3)		
3 - 5	131 (11.0)	27 (10.7)	14 (5.4)		
6 or older	74 (6.2)	12 (4.8)	5 (1.9)		
Exclusively breastfed (months)				25.73	.001
No	664 (55.7)	148 (58.7)	183 (70.2)		
< 1	265 (22.3)	58 (23.0)	51 (19.5)		
1 - 2	82 (6.9)	13 (5.2)	13 (5.0)		
3 - 5	121 (10.2)	22 (8.7)	11 (4.2)		
6 or longer	58 (4.9)	11 (4.4)	3 (1.1)		
Anthropometrics					
BMI% at 2 y.o.				311.40	.000
Normal	418 (79.8)	29 (31.2)	9 (8.1)		
Overweight	69 (13.2)	40 (43.0)	32 (28.8)		
Obese	31 (5.9)	24 (25.8)	70 (63.1)		

Binary logistic regression modeling

Bivariate analyses indicated an association between exclusive breastfeeding and the outcome variable. However, chi-square test for association did not measure to what extent exclusive breastfeeding reduces the risk of developing childhood overweight or obesity. Further, it did not measure to what extent exclusive breastfeeding may reduce the risk independent of other contributing factors. Therefore, binary regression analyses were conducted to explore the relationship further.

Bivariate logistic regression requires a dichotomous variable as well as established reference category within each variable. Therefore, additional re-coding constructed appropriately formatted variables for use in this analytic process. The outcome variable, BMI percentile at three years of age, was recoded into a dichotomous variable with two categories: normal (5 to 84 percentiles) and overweight/obese (> 85 percentile). The same treatment was applied to the prepregnancy BMI variable, which was recoded into normal (< 25 kg/m2) and overweight/obese (> 25 kg/m2) categories. All independent variables were recoded so that their respective reference categories were coded as the lowest value (0). This allowed all covariates to be entered in the same manner.

As mentioned earlier, because of the low numbers of cases with BMI percentiles at age two years, this variable was removed from further analysis. In addition, the age of introduction of supplemental feedings was used to construct the exclusive breastfeeding variable, and therefore was not included in the final analysis. Finally, the literature reported equivocal results regarding the effect of breastfeedings on the risk for overweight/obesity. Bivariate analysis revealed that within this study sample, the length of time an infant was breastfed (p = .092) and the history of ever being breastfed (p = .745) were not significantly associated with the outcome variable, therefore these two variables were also excluded from the final analysis.

Three models were tested to determine the best fit for data predicting BMI percentile in the overweight/obese range in three-year-old children in this study sample. First, exclusive breastfeeding was entered into the model to determine its effect on overweight/obesity without adjusting for other covariates. Then all covariates were entered followed by selection of the Hosmer-Lemeshow's goodness of fit and 95% confidence intervals (CI) for odds ratios.

During the first two models, a forward stepwise and the forced-entry methods were used. However, because of the results of the bivariate analyses and previous research results that support the inclusion of these covariates, the forced-entry method was selected as the final method. The results of the first two models also indicated that the smoking history and the level of maternal education did not make significant contributions to the explanatory power and therefore these two variables were removed. The following statistical test results confirmed the third model was an appropriate fit for analyzing these data: a nonsignificant Hosmer - Lemeshow Test for goodness of fit (p = 1.000) and a significant Omnibus Tests of Model Coefficients for step, block and model (p = .000).

Next, all cases with data in the seven remaining independent variables (n=1,452) were identified as final analytic sample. Univariate analysis of the analytic sample was conducted to evaluate the distribution of characteristics among the selected cases (see Table 10). Results appeared similar to the univariate results from the original study sample. However, there was a reduction in the number of non-Hispanic black cases, and non-Hispanic white, plus an increased proportion in those who were Hispanic. Overall, the results described an analytic sample with a majority of mothers who were 25 years of age or younger (55.5%), accessed prenatal care within the first trimester (74.7%), and were overweight or obese (59%) prior to this pregnancy. None of the three racial/ethnic categories represented more than 48.8% of the sample.

The child cases retained in the analytic sample also appeared similar to those in the original study sample. A large percentage of children (83.4%) had a normal birth weight and 40.8% were exclusively breastfed for some time. Within the analytic sample, 30.2% of children were in the overweight/obese BMI percentile at three years of age, which was similar to the 32.0% rate noted in the original study sample. However, to test for significant differences in the distribution of demographic and health-related factors between the analytic and study samples, chi-square analysis was performed. Results indicated that the analytic sample cases have similar distributions in the selected variables except for race/ethnicity (see Table 10). Finally, to test the associations between the main independent variable, selected covariates and the outcome variable in the analytic sample, a fourth chi-square analysis was conducted with the final analytic sample cases. Table 11 displays the results, which indicated similar associations as seen in the study sample. These steps confirmed the decision to proceed with binary logistic regression, with the analytic sample cases and listed variables.

Table 10. Analytic sample: distribution of characteristics

Maternal	**n=1,452**
Demographics	
Age (years)	
< 21	471 (32.4)
21 - 25	335 (23.1)
26 - 30	286 (19.7)
> 30	360 (24.8)
Race/ethnicity	
Hispanic	620 (42.7)
Non-Hispanic black	124 (8.5)
Non-Hispanic white	708 (48.8)
Health history	
Pre-pregnancy BMI	
Normal	595 (41.0)
Overweight/obese	857 (59.0)
Prenatal care initiation	
Timely start	1,085 (74.7)
Untimely start	367 (25.3)
Child	**n=1,452**
Health history	
Birth weight	
LBW	92 (6.3)
NBW	1,211 (83.4)
HBW	149 (10.3)
Exclusively breastfed (months)	
No	859 (59.2)
< 1	312 (21.5)
1 - 2	96 (6.6)
3 - 5	128 (8.8)
6 or longer	57 (3.9)
BMI percentiles at 3 years old	
Normal	1,013 (69.8)
Overweight/obese	439 (30.2)

Table 11. Comparison of analytic and non-included cases

	Analytic sample n (%)	Not included n (%)	χ^2	*p*
Maternal				
Age (years)				
N= 2,495 (100)			7.16	.067
< 21	471 (32.4)	345 (33.1)		
21 - 25	335 (23.1)	228 (21.9)		
26 - 30	286 (19.7)	172 (16.5)		
> 30	360 (24.8)	298 (28.5)		
Race/ethnicity				
N= 2,404 (96.4)			48.07	.000
Hispanic	620 (42.7)	277 (29.1)		
Non-Hispanic black	124 (8.5)	121 (12.7)		
Non-Hispanic white	708 (48.8)	554 (58.2)		
Pre-pregnancy BMI				
N= 2,307 (92.5)			3.02	.082
Normal	595 (41.0)	382 (44.7)		
Overweight/Obese	857 (59.0)	473 (55.3)		
Timing of prenatal care				
N= 2,379 (95.4)			0.10	.753
Timely start	1,085 (74.7)	698 (75.3)		
Untimely start	367 (25.3)	229 (24.7)		
Child				
Birth weight				
N= 2,495 (100)			1.34	.500
LBW	92 (6.3)	78 (7.5)		
NBW	1,211 (83.4)	864 (82.8)		
HBW	149 (10.3)	101 (9.7)		
Exclusively breastfed (months)				
N= 1,779 (71.3)			6.15	.188
No	859 (59.2)	179 (54.7)		
< 1	312 (21.5)	74 (22.6)		
1 - 2	96 (6.6)	20 (6.1)		
3 - 5	128 (8.8)	32 (9.8)		
≥ 6	57 (3.9)	22 (6.8)		

Table 12. Analytic sample: bivariate associations

	Normal weight % n (%)	Overweight/ obese% n (%)	χ^2	*p*
Maternal Demographics				
Age (years)			5.83	.120
< 21	268 (26.4)	92 (21.0)		
21 - 25	324 (32.0)	147 (33.5)		
26 - 30	232 (22.9)	103 (23.5)		
> 30	189 (18.7)	97 (22.0)		
Race/ethnicity			2.90	.234
Hispanic	418 (41.2)	202 (46.1)		
Non-Hispanic black	90 (8.9)	34 (7.7)		
Non-Hispanic white	505 (49.9)	203 (46.2)		
Health History				
Pre-pregnancy BMI			18.36	.000
Normal	452 (44.6)	143 (32.6)		
Overweight/obese	561 (55.4)	296 (67.4)		
Timing of prenatal care			0.55	.280
Timely start	752 (74.2)	535 (77.2)		
Untimely start	261 (26.1)	106 (24.1)		
Child Health History				
Birth weight (grams)			10.50	.005
LBW	63 (6.2)	29 (6.6)		
NBW	863 (85.2)	348 (79.3)		
	87 (8.6)	62 (14.1)		
Exclusively breastfed (months)			17.57	.001
No	567 (56.0)	292 (66.6)		
< 1 month	225 (22.2)	87 (19.8)		
1 to 2	73 (7.2)	23 (5.2)		
3 to 5	102 (10.1)	26 (5.9)		
6 or longer	46 (4.5)	11 (2.5)		

Binary logistic regression results

Binary logistic regression tested to what extend exclusive breastfeeding predicts overweight/obesity in children at three years of age (n=1,452) given the duration of exclusive breastfeeding and controlling for other associated factors. Results of the binary logistic regression are displayed in Table 13.

The variables were entered in two steps. Exclusive breastfeeding was entered in the first block, which was significant at p = .001. The Hosmer- Lemeshow Test was not significant (p= 1.000) and thus confirmed a goodness of fit. Next, the six covariates were entered. Again, the Hosmer-Lemeshow Test confirmed a goodness of fit with a nonsignificant calculated chi-square test value (χ^2 = 13.13 (8), p = .108). Overall, the accuracy of the model for predicting group membership (normal BMI percentile or overweight/obese BMI percentile at three years of age) was 69.6%. Three variables were nonsignificant and thus not predictive of group membership in this sample. The variables were maternal age, race/ethnicity, and prenatal care initiation.

Similar to results observed with bivariate analyses, the inferential statistical analysis revealed three predictor variables. An overweight/obese maternal prepregnancy BMI was a strong predictor (OR = 1.54, 95% CI [1.21, 1.96], p= .001) for the child's overweight/obesity. Therefore, the likelihood that a child, born to a mother who was overweight/obese prior to the pregnancy, will be overweight/obese at three years of age is 1.54 times higher than that of child born to a mother whose prepregnancy BMI was normal. An equally strong predictor was a birth weight greater than 4000 grams (OR = 1.69, 95% CI [0.71, 1.81], p = .004). Three-year old children born with a birth weight of at least 4,000 grams were 1.69 times more likely to be overweight/obese than those born with a normal birth weight.

Exclusive breastfeeding, the main independent variable, was also found to be a statistically significant predictor. Unadjusted for other contributing factors, exclusive breastfeeding increasingly reduced risk for overweight/obesity as the duration of breastfeeding increased from less than one month (OR=0.75, 95% CI[0.57,0.99], p = .049) to three to five months (OR=0.50, 95%CI[0.32,0.78], p = .002). Adjusting for effect of other contributing factors modified the effect was modified, however children exclusively breastfed three to five months had statistically significant lower odds of being overweight/obese at age three than those who were not exclusively breastfed (OR= 0.48, 95%CI[0.30, 0.76], p = .002). Also, children exclusively breastfed six months or longer had lower odds of being overweight/obese at age three (OR, 0.46, 95% CI[0.23, 0.92), p = .028). However, in both the unadjusted (p= .002) and adjusted analysis (p = .002), the duration of three to five months of exclusive breastfeeding appeared to have the strongest statistical effect. Similarly, the effect of the six months or more of exclusive breastfeeding was not as strong in the both the unadjusted analysis (p = .025) and the adjusted analysis (p =.028) as seen at three to five months.

Table 13. Odds ratio results

	Overweight/obese %			Overweight/obese %		
	Odds ratio	**95% CI**	***p***	**Odds ratio**	**95% CI**	***p***
Exclusively breastfed (months)						
No	--	--	--	--	--	--
< 1	0.75	(0.57, 0.99)	.049	0.78	(0.58, 1.05)	.099
1 to 2	0.61	(0.38, 0.99)	.049	0.66	(0.40, 1.09)	.108
3 to 5	0.50	(0.32, 0.78)	.002	0.48	(0.30, 0.76)	.002
≥ 6	0.46	(0.24, 0.91)	.025	0.46	(0.23, 0.92)	.028
Age (years)						
< 21				0.81	(0.59, 1.12)	.194
21 to 25				--	--	--
26 to 30				0.92	(0.67, 1.25)	.563
> 30				1.04	(0.75, 1.44)	.806
Race/ethnicity						
Hispanic				1.05	(0.82, 1.37)	.655
Non-Hispanic black				0.85	(0.55, 1.32)	.480
Non-Hispanic white				--	--	--

Table 13 (cont.)

	Overweight/obese %			**Overweight/obese %**		
	Odds ratio	95% CI	***p***	**Odds ratio**	**95% CI**	***p***
Pre-pregnancy BMI						
Normal				--	--	--
Overweight/obese				1.54	(1.21, 1.96)	.001
Prenatal care initiation						
Timely				--	--	--
Untimely				0.88	(0.67, 1.15)	.334
Birth weight						
LBW				1.14	(0.71, 1.81)	.593
NBW				--	--	--
HBW				1.69	(1.18, 2.42)	.004

The results of the univariate analysis revealed a sample of mother/infant pairs with potential risk factors for early childhood overweight/obesity. Bivariate analysis indicated that in this sample, six of the factors examined in this study were significantly associated with a child's risk for overweight/obesity at three years of age. Further, binary regression analysis indicated that exclusive breastfeeding was a significant predictor of risk for overweight/obesity at three years of age, even when adjusted for other significant contributing factors. These results informed the following responses to the four proposed research questions.

Research Question I. What associations exist between observed risk factors in the study sample and overweight/obesity at three years of age? Univariate statistical analysis of the study sample revealed a number of potential risk factors. Within the study sample (N=2,495), 59% of mothers had an overweight/obese prepregnancy BMI, 39% had not completed a high school level education, 26% had a positive smoking history, and 25% did not receive prenatal care until after the first trimester. Race and ethnicity were largely distributed among three race/ethnic groups of which non-Hispanic whites and Hispanics made up 87% of the sample. In the child cases, 10% were born at or above 4,000 grams, 11% were born after 40 weeks gestation, 30% were never breastfed, 76% of breastfed infants received supplemental feeding before one month of age, and 36% were overweight/obese at age 2 years.

Bivariate tests for associations measured statistically significant associations between maternal prepregnancy BMI, education level, and race/ethnicity and the outcome variable. No association was found between maternal age, timing of prenatal care initiation, and smoking history and child overweight/obesity at three years of age. In children, birth weight, age at which supplementary feeding were begun, exclusive breastfeeding and BMI-for –age percentile at two years of age were significantly associated with child overweight/obesity at three years old.

Within the analytic sample (n=1,452), bivariate tests revealed statistically significant associations between the mother's pre-pregnancy BMI (p = .000), infant's birth weight (p = .005), exclusive breastfeeding (p = .001) and the risk for overweight/obesity at three years of age. Regression analysis also revealed that all three of these factors (maternal BMI, birth weight, and exclusive breastfeeding) are significant predictors of overweight/obesity at three years of age.

Except for race/ethnicity, the univariate and bivariate statistical tests demonstrated similar distribution of characteristics within the original study and final analytic samples. In the original study sample, race/ethnicity was strongly associated with the child's likelihood of overweight/obesity at three years of age. Maternal education level was also significantly associated with the outcome variable. However, these two associations were not observed in the final analytic sample.

Research Question II. What is the association between different durations of exclusive breastfeeding and overweight and obesity at three years of age? Within the analytic sample, 40.8% of infants were reported to have been exclusively breastfed. Bivariate statistical analyses indicated that infants who were exclusively breastfed were less likely to be overweight/obese at three years of age (p = .001). Unadjusted binary logistic regression analysis revealed that infants who were exclusively breastfed had lower odds of overweight/obesity at three years of age compared to those who were not exclusively breastfed (p <.05). Further, the results indicated a trend in which the odds for developing overweight/obesity at the age of three decreased, as the duration an infant exclusively breastfed increased. The odds of being overweight/obese at age three years decreased 25% in infants exclusively breastfeeding for less than one month compared to an infant who was not exclusively breastfed. The odds decreased by 39%, then 50%, and further by 64% for infants breastfed for one - two months, three to five months, and six months or longer, respectively.

Therefore, the null hypothesis that infants exclusively breastfed for different lengths of time have similar risk for overweight/obesity at three years of age was rejected.

Research Question III. Do infants that are exclusively breastfed for different lengths of time have different risks for overweight and obesity at three years of age after adjusting for maternal education level?

Univariate analyses of the original study sample revealed that 61.3% of mothers had at least a high-school-level education and 38.7% had less than 12 years of education. Results of bivariate analyses indicated an association between the mother's education level and the child's BMI-for age percentile at age three years (χ^2 = 12.51(4), p = .014). . However, initial binary regression modeling indicated that maternal education did not contribute to the prediction of group membership; the maternal education variable was not included in the final regression analysis. Therefore, the null hypothesis that infants exclusively breastfed for different lengths of time have similar risk for overweight/obesity at three years of age, when controlled for maternal education was not rejected.

Research Question IV. Do infants who are exclusively breastfed for different lengths of time have different risk for overweight/obesity at three years of age when other contributing factors exist?

The unadjusted odds ratios for risk of overweight/obesity at age three years of age in infants exclusively breastfed, were significant different compared to infants who were not exclusively breastfed. Binary logistic regression analysis also demonstrated a trend in which the odds of being overweight/obese at age three decreased as the duration of exclusive breastfeeding increased. However, the adjusted odds ratios were not statistically significant for infants who were exclusively breastfed for less than three months. The odds of an infant, who was exclusively breastfed for three to five months, of being overweight/obese at age three were 0.48 times less than those of an infant who was not exclusively breastfed (OR = 0.48, 95% CI [0.32, 0.78], p = .002). Similarly, the odds of an infant, exclusively breastfed for six months, of being overweight/obese at age three was 0.46 times less than those of an infant who was not exclusively breastfed (OR = 46, 95% CI[0.23, 0.92], p = .028), regardless of other significant contributing factors.

Therefore, the null hypothesis that infants who are exclusively breastfed for different lengths of time have similar risk for overweight/obesity at three years of age, when controlled for known contributing factors, was rejected.

Summary

The final analytic sample contained 1,452 pairs of linked, mother/child cases from the Kansas WIC program. Over half of the mothers were 25 years of age or younger (55.5%) and were overweight or obese (59%) prior to this pregnancy. Almost three quarters (74.7%) accessed prenatal care within the first trimester. There were three predominant racial/ethnic racial categories: Hispanic, non-Hispanic white, and non-Hispanic, black. A large percentage of children (83.4%) had a normal birth weight and 40.8 % were exclusively breastfed for some length of time. Within the analytic sample, 30.2 % of children were in the overweight/obese BMI percentile at three years of age.

Overall, univariate, bivariate, and inferential statistical analyses of the cases included in the final analytic sample, indicated statistically significant results that supported the proposed relationship between exclusive breastfeeding and risk for overweight and obesity at three years of age. Specifically, findings revealed that a possible dose-related relationship exists between exclusive breastfeeding and a reduced risk for overweight/obesity in the preschool child. The analyses indicated that the longer an infant is exclusively breastfed, regardless of other influencing factors such as high maternal prepregnancy BMI, maternal age, race/ethnicity, prenatal care and infant high birth weight, the less the odds of developing overweight/obesity by three years of age.

CHAPTER FIVE: DISCUSSION

Introduction

The purpose of this retrospective study was to explore the relationship between duration of exclusive breastfeeding and risk for overweight/obesity at three years of age. The study used linked, longitudinal data collected on mothers and children who participated in the Kansas state Special Supplementary Nutrition Program for Women, Infants, and Children (WIC) from 2008 through 2011. These data were reported in the Pediatric and the Prepregnancy Nutrition Surveillance Systems (PedNSS & PNSS) which were managed by the Centers for Disease Control and Prevention (CDC).

A search of the literature supported selection of the main independent and outcome variables for conducting this study. Univariate analyses provided a composite profile of the study and final analytic samples. Bivariate analyses measured associations between the main independent variable (exclusive breastfeeding), other contextual factors, and risk for child overweight/obesity at three years of age. Binary logistic regression modeling was used to measure the probability of overweight/obesity at three years of age, given the different lengths of time of exclusive breastfeeding. In addition, when adjusted for other covariates, the logistic model measured if exclusive breastfeeding continued to make significant contribution to the prediction of reduced risk for overweight/obesity.

The following discussion considers how the findings of this study extend the understanding about the relationship among these variables, and in particular, how they inform answers to the research questions. Results are discussed within the context of current literature reported in chapter two, the 2008 Kansas WIC population report (when data available) and the 2008 national WIC population report (KHD, 2008; Reinold, Dalenius, Brindley, Smith, & Grummer-Strawn, 2010). The chapter finishes with a discussion of the strengths and limitations of the study, with implications for nursing practice, policy, and future research.

Maternal variables

The initial study sample consisted of 2,495 linked pairs of maternal/child cases. Descriptive analyses revealed that compared to the 2008 national PNSS population, mothers in this study sample were somewhat younger; less educated and had higher prepregnancy BMIs. They were also less likely to have smoked or to delay initiation of prenatal care. Of importance to the following discussion, there was a significant difference in the race/ethnic distributions in this study sample compared to the 2008 national PNSS population. In 2008, non-Hispanic blacks represented 24% of the national PNSS population, whereas in this study sample, only 9.8% of mothers were non-Hispanic black. The low number of non-Hispanic black cases in the analytic sample is partially explained by the reported breastfeeding rates within this racial/ethnic group. In 2008, non-Hispanic black mothers had the lowest rate (59.9%) of breastfeeding initiation among PNSS mothers, compared to 76.5% of non-Hispanic white mothers, and 82.1% Hispanic mothers (Polhamus, Dalenius, Mackentosh, Smith, Grummer-Strawn, 2009; Reinold, Dalenius, Brindley, Smith, & Grummer-Strawn, 2010).

Bivariate analysis identified that three of the six maternal variables were significantly associated with child overweight/obesity at age three: race/ethnicity, education, and prepregnancy BMI. Yet only maternal pre-pregnancy BMI emerged as a significant predictor in the regression analysis. Previous studies reported significant effect of race/ethnicity on a child's BMI. Sharma, Cogswell, and Li (2008), conducted a study using linked PNSS and PedNSS data files from nine U.S. states, and found that the lowest prevalence of obesity was observed among children born to non-Hispanic white mothers and the highest was observed among children born to Hispanic mothers. Another study by Procter and Holcomb (2008) also used linked PNSS and PedNSS data and reported similar observations where race/ethnicity was a significant contributor to overweight at age four years. It is important to emphasize that the race/ethnicity distributions in their research projects differed from observed distributions in this study.

Sharma, Cogswell, and Li (2008) as well as Procter and Holcomb (2008) reported non-Hispanic white mothers represented a significant majority of their study samples. Further that the non-Hispanic white groups were 30% to 40% larger than the next largest race/ethnic groups (Hispanic) in their samples. Whereas all cases included in this analytic sample had breastfeeding data, the number of non-Hispanic black cases was significantly reduced. Further, Hispanic and non-Hispanic white mothers had the highest rate of breastfeeding reported in the 2008 PedNSS population (Polhamus, Dalenius, Mackentosh, Smith, Grummer-Strawn, 2009). Therefore, 92% of cases in this study were similarly distributed between two race/ethnic groups, which mitigated the effect observed in other studies.

PNSS and PedNSS cases in this study represented families who existed at or below 185% of the U.S. federal poverty level, unless Kansas WIC granted an exception to the economic criterion for participation. Mothers' completed years of education was added as an independent variable to enhance measurement of a family's socioeconomic resources. Although the bivariate association between education and the outcome variable was significant, the regression model indicated education achievement did not contribute to the prediction of risk for overweight/obesity in this analytic sample. Weden, Brownell, and Rendall (2012) reported that in their study, the odds ratio for increased risk of overweight in children with mothers who completed less than 12 years, compared to 12 years of education, approached statistical significance. Their study sample compared non-Hispanic black children and non-Hispanic white children. Further, Sing, Siahpush, and Kogan (2010) found children of parents with less than 12 years of education were 3.1 times more likely to be overweight/obese. However, close to 55% of their sample had income 200% or greater than the federal poverty threshold compared to this project's sample that was at or below 185%. While education appeared to have an association to risk of overweight/obesity in this study sample, it did not contribute significantly to the predictor model. This observation may indicate that education and economic levels are highly correlated and or that exclusive breastfeeding, in this sample, did not significantly vary among different levels of education.

Maternal age, smoking history, and timing of prenatal care initiation were not significantly associated with the outcome variable in this study. Maternal age was used to describe the characteristics of this sample. Bivariate association between maternal age and child overweight/obesity approached significance. Observed trends suggested obese children were more likely to be associated with mothers younger than 21 years and older than 26 years, whereas overweight children were more likely to have mothers who were 21 to 25 years old. However, there was no significant effect when maternal age was included in the logistic regression analyses. Recent studies also reported that maternal age was not statistically significant in their study sample or was used to control for possible confounding factors (Kitsantas & Gaffney, 2010; Lamb, et al., 2010; Sharma, Cogswell, & Li, 2008). While not a significant predictor in this study, the observed association may reflect other maternal age-related factors contribute to a child's risk.

The rate of smoking in this study sample was lower compared to the 2008 Kansas WIC mothers (KHD, 2008), and slightly higher than reported in the national 2008 PNSS population (Reinold, Dalenius, Brindley, Smith, & Grummer-Strawn, 2010). Although the literature reported statistically significant associations between maternal smoking and childhood obesity, no significant association was observed in this sample. The non-significant results may reflect difference in measurement methods. Sharma, Cogswell, and Li (2008) categorized smoking history to reflect the duration of smoking during pregnancy only. They found a significant association between duration of smoking and obesity among children born to non-Hispanic White mothers. Kitsantas and Gaffney (2010) also found overweight/obese preschool children in their study were more likely to have mothers who smoked during pregnancy.

In this study, history of smoking included pregestational, prenatal, gestational, and postpartum smoking history. Including all levels of smoking may have obscured the effect of smoking during pregnancy as observed in other studies. However, Twells and Newhook (2010) measured a mother's current –not pregnancy - smoking status in their study of the risk reduction effect of exclusive breastfeeding in a convenient sample of Canadian preschool children. Their findings indicated the odds for being obese by preschool age were 1.48 times higher in children whose mothers currently smoked compared to children whose mothers were not currently smoking.

Almost 75% of mothers in this study sample initiated prenatal care before the end of the first trimester, which was the same percentage as observed in the 2008 Kansas WIC population, yet lower than the 81% reported in the 2008 national PNSS population (KHD, 2008; Reinold, Dalenius, Brindley, Smith, & Grummer-Strawn, 2010). Initial regression models indicated this variable contributed to the predictive capacity of the model however, no significant effect was evident. As Stuebe and Bonuck (2011) found in their intervention study on predicting intent to breastfeed exclusively, women who understood the benefits of exclusive breastfeeding were more likely to intend to exclusively breastfeed. The authors also noted prenatal care offered an opportunity to educate pregnant women regarding benefits of exclusive breastfeeding. Therefore, earlier access to prenatal care may translate to greater exposure to information regarding exclusive breastfeeding. WIC programs offer prenatal breastfeeding education as well as peer breastfeeding support programs. However, maternal record of participation in these programs is not included in the PNSS data files.

The one maternal variable that demonstrated a strong association with and significant predictor of child overweight/obesity at three years of age was prepregnancy BMI. Specifically, maternal prepregnancy overweight/obesity was strongly associated with and predictive of child overweight/obesity at three years of age. These findings are consistent with results of other studies. Olson, Demment, Carling, and Strawderman (2010) reported a significant association between maternal early pregnancy BMI and the child's risk for obesity at four years of age. Kitsantas and Gaffney (2010) reported that the odds of a child being overweight/obese at four years where significantly higher if their mother was overweight/obese before pregnancy compared to children of mother's with normal prepregnancy weight. Maternal prepregnancy overweight/obesity was also significantly associated with overweight at four years of age in Procter and Holcomb's (2008) study.

The physiological changes associated with maternal pregestation overweight/obesity may compound or be compounded by gestational factors, which may influence fetal development with both immediate as well as extended effect to early infancy – or longer. The significant findings in this study confirm observations in previous studies and suggest that within a LCHD model, there is opportunity for evidence-based interventions. The logistic regression model indicated regardless of maternal prepregnancy BMI, exclusive breastfeeding for at least 3 – 5 months was effective at reducing risk for early childhood overweight/obesity.

Child variables

Children included in the study sample were born in 2008. Descriptive analyses indicated the sample had an even representation of male and female children in which most were born at full term and within a normal weight range. Bivariate analyses identified four out of the eight child-related factors were significantly associated with child overweight/obesity at three years of age. They were birth weight, age supplemental feeding was introduced, exclusively breastfed duration, and BMI percentile at two years of age. Child gender, gestational age, history ever being breastfed, and history of breastfeeding duration were not significant. .

Ogden, Carroll, Kit, and Flegal (2012) compared trends in childhood obesity using National Health and Nutrition Examination Survey (NHANES). They found that the prevalence of obesity among boys had increased from 14.0% to 18.6% between 1999 and 2010 yet no significant change was observed among girls. Procter and Holcomb (2008) reported significant univariate association (OR = 1.23, 95% CI [1.03, 1.46]) between male gender and overweight at four years of age, in their analyses of linked PNSS and PedNSS data analysis from 1998 - 2002. However, other studies did not report significance or used gender to control for confounding variables (Kitsantas & Gaffney, 2010; Sharma, Cogswell, & Li, 2008; Twells & Newhook, 2010, Weden, Brownell, & Rendall, 2012).

Bivariate tests for association in this study sample revealed no significant association between gender and overweight/obesity at three years of age. Differences in the race/ethnicity distributions between the Proctor and Holcomb (2008) study and this research project may explain the lack of observed effect in this study. This study sample had a much larger proportion of Hispanic cases compared to Procter and Holcomb. Recently, Lamb, et al, (2012) published results of a study that examined early life predictors of childhood obesity in a sample of children in which 72% were Hispanic. Conducting multivariate regression analyses, they reported no statistically significant difference between males and female subjects. Therefore, the large proportion of

Hispanic cases within this study sample might have mitigated the gender effect seen in other studies, especially those reporting national trends.

Overall, a majority of children included in this study were born at term, which described a predominantly healthy infant sample. No significant association between gestational age and the outcome variable was observed with bivariate analyses. Weden, Brownell, & Rendall (2012) as well as Kitsantas and Gaffney (2010) also reported non-significant results when examining association between gestational age and risk for early childhood overweight/obesity. However, Twells and Newhook (2010) reported that a history of full term gestation reduced a child's risk for obesity at preschool by 28%. The lack of bivariate association, along with limited results reported in the literature eliminated this variable from further analyses.

Within this study sample 10% of children weighed more than 4,000 grams at birth, which was a higher rate than observed in the 2008 Kansas and national PedNSS populations (KHD, 2008; Polhamus, Dalenius, Mackentosh, Smith Grummer-Strawn, 2009). Further, bivariate analyses revealed infants with a high birth weight in this sample were more likely to be overweight/obese at three years of age. There was also a trend toward overweight/obesity within the low birth weight category. In comparison, normal birth weight infants were less likely to be overweight and obese at three years of age. The literature also reported significant associations between high birth weight and child overweight/obesity (Lamb, et al., 2102: Weden, Brownell, & Rendall, 2012; Kitsantas & Gaffney, 2010; Butte, 2009).

The rate of breastfeeding in this sample was similar to that reported in the 2008 Kansas WIC population yet slightly higher than observed in the 2008 national WIC population. Of those breastfed, less than half breastfed beyond one month of age and by six months less than a quarter continued breastfeeding, which was somewhat higher than the 2008 Kansas WIC but lower than reported in the 2008 national PedNSS populations (KHD, 2008; Polhamus, Dalenius, Mackentosh, Smith Grummer-Strawn, 2009). The two variables that measured breastfeeding (history of ever breastfed and length of breastfeeding) in this study were not significantly associated with child overweight/obesity at three years of age. This observation was consistent with weak and equivocal results reported from studies exploring breastfeeding's effect on risk for childhood overweight/obesity Grummer-Strawn & Mei, 2004; Huus, Ludvigsson, Enskär & Ludvigsson, 2008; Procter & Holcomb, 2008; and Butte, 2009). One significant issue is the definition of breastfeeding. A breastfed infant who received a significant volume of supplemented feedings would be included in the same category as an infant who may receive one supplemental feeding a day. The PedNSS survey does not differentiate amounts of supplemental feedings; therefore, there are limitations imposed by the measurement of breastfeeding in this data set.

The timing of introduction of supplemental feeding was a measure applied only to infants who had been breastfed. Because the timing of introduction of the supplemental feedings variable was used to construct the exclusive breastfeeding variable, it was not surprising that its association with overweight/obesity at three years of age was similar to exclusive breastfeeding. It also indicated that the exclusive breastfeeding variable functioned as a reliable measure. Therefore, the supplemental feeding variable was not included in the final analysis

Univariate analysis revealed 42% of infants in the study sample were exclusively breastfed, however only 20% were exclusively breastfed up to one month of age and only 13% were breastfed for at least three months. In 2008, just over a third of participating PedNSS contributors reported data on exclusive breastfeeding rates. Within this sub-population, 8% of infants were exclusively breastfed up to 3 months of age. Therefore, this study sample had a higher rate of exclusive breastfeeding at three months of age than reported by other states providing this data.

Results of logistic regression analyses indicated a statistically significant, independent effect of exclusive breastfeeding on reducing the risk for overweight/obesity at three years of age. Specifically, the longer an infant was exclusively breastfed, the lower the risk for overweight/obesity. Furthermore, when controlled for maternal age, race/ethnicity, prepregnancy BMI, prenatal care initiation, and child's birth weight, the effect of exclusive breastfeeding persisted. Although the dose-related trend was observed in the calculated odds ratio, statistical significance did not emerge until the three to five month category and did continue through the six-month or longer category.

Huus, Ludvigsson, Enskär & Ludvigsson, (2008) examined the relationship between exclusive breastfeeding and risk for obesity in five-year-old children. The authors reported that short-term exclusive breastfeeding (less than four months) was associated with reduced risk for obesity in five-year-old children but when other contributing factors were included, the effect did not attain statistical significance. Lamb, et al., (2010) reported that univariate analysis identified shorter duration of breastfeeding was associated with higher childhood BMI, but exclusive breastfeeding was not. Further, results of the multivariate regression analysis in their analytic sample did not measure significant effect of breastfeeding duration on risk for childhood BMI. In their study, the outcome variable (BMI for age and sex) was measured between two and eleven years of age rather than only at one age for all cases.

However, this study, based on the LCHD model proposed that multiple contributing and compounding factors occur of the course of childhood. Further, that risk reduction factors such as breastfeeding may have time-limited effect. Therefore, the inconsistencies observed between results of this study and previous studies may be explained by the period of time that lapsed between the end of exposure to exclusive breastfeeding and measurement of the outcome variable (BMI).

WIC conducts standardized methods of child anthropometric measurements on children from birth to age five. Children who participated in the PedNSS surveillance program had measurements recorded in the program's database. While 97.5% of the study sample had recorded birth weights, only 30% of this study sample had recorded anthropometric measurements at or around their two-year birthday. The limited number of cases excluded this variable from the final analysis.

The overall accuracy of the final binary regression model for predicting group membership (normal BMI percentile or overweight/obese BMI percentile at age three years) was 70%. While the model's accuracy rate was excellent (95%) in classifying cases that had normal BMI-for age percentile at three years of age, it performed poorly

(5% of cases) in classifying those who did not have a normal BMI-for-age percentile. However, the purpose of this study was to determine if duration of exclusive breastfeeding reduces the risk for overweight/obesity at three years of age. Therefore, this model was overall useful in predicting exclusively breastfed cases' membership.

According to the results, the odds of an infant in this study being overweight/obese at three years of age increased if the mother was overweight/obese prior to the pregnancy, the infant was born weighing 4,000 grams or more, and was not exclusively breastfed. Conversely, normal maternal prepregnancy BMI, normal birth, weight, and duration of exclusive breastfeeding contributed significantly to a reduced likelihood of early childhood overweight and obesity. Statistically significant, adjusted odds ratios indicated that regardless of maternal overweight/obesity and high infant birth weight, exclusive breastfeeding for at least three months reduced and infants risk for overweight/obesity at three years of age.

Strengths

A major strength of this research project is the use of the Life Course Health Development (LCHD) model that framed the design, analyses, and interpretation of the results. Within the LCHD model, the child's health trajectory represents a dynamic process that is responsive to preventative and restorative nursing interventions. The results of this research project extends the work of previous studies examining exclusive breastfeeding as an effective preventative factor in reducing risk for early childhood overweight and obesity (Grummer-Strawn & Mei, 2004; Huus, Ludvigsson, Enskär & Ludvigsson, 2008; Butte, 2009; Twells & Newhook, 2010; & Lamb, et al., 2010:).

The cross sectional design supported the examination of previously known factors as well as exclusive breastfeeding in relation to overweight/obesity, within a specific population, and within a defined period in a child's development. It examined associations between factors and the outcome as well as modeled the predictive features of these factors. In addition, the use of linked maternal and child data sets represented the pre-gestational, gestational, and socioeconomic context of the child's health trajectory. Further, standardized measurements of height and weights with recorded dates at time of measurement provided accurate clinical and temporal data compared to measurements reported by recall and separated by significant time, which imposes limits to data accuracy.

While the PNSS and PedNSS data set represented a sub-population of the U.S. defined by low socio-economic resources that limits generalizability of these results, it also provided an opportunity to examine the effect of exclusive breastfeeding in a specific population and develop relevant recommendations for that population. Finally, because the data was collected within the past three to five year (2008 – 2011), interpretation and recommendations are relevant to the current socio-economic and political environment.

Limitations

Predetermined design, definitions, measurements, and data collection methods impose limits on secondary data analyses research projects. The PedNSS and PNSS programs were designed to collect data on the health and nutrition status of mothers, infants, and young children participating in a federally funded program designed for U.S.

citizens existing at or below the 185% of the federal poverty level. While the entire national PedNSS and PNSS database provides national representation of a specific population, this project represents only one state, which further limits generalizability of the results. Participation in the PNSS and PedNSS programs is voluntary. Therefore, cases included in the data set may represent an additional level of bias.

Finally, the cross sectional study design imposes restrictions to the interpretation and generalization of the results. A cross sectional design limits sampling which contributes to the restricted application of results. It also does not examine the changes over time, as would a longitudinal design. However, the results did indicate exclusive breastfeeding had a significant risk reduction effect in early childhood overweight/obesity in this sample and therefore supports designing a longitudinal project to examine further the relationship between these two variables.

Implications

Practice. Pediatric health practitioners face significant challenges in providing quality care. State regulations that restrict advance practice nurses' scope of practice, varying reimbursement codes, rates and levels, more complex and chronic health problems managed in the primary care setting, and a lack of pediatric specialists as well as resources place extraordinary demands on practitioners (Halfon, DuPlessis, & Inkelas, 2007; IOM, 2011). Providers need evidence-based recommendations that improve the quality of care as well as the efficiency of their practice.

WIC programs serve a population of women and children who, in general, face significant economic uncertainty. Staffs that provide services for these families face additional challenges. In a qualitative, descriptive study Reifsnider, Gill, Villarreal, and Tinkle, (2003) explored WIC personnel's perceptions regarding their client's views of breastfeeding. They identified multiple levels of challenges in supporting and improving breastfeeding rates within their client population including, individual, familial, cultural, system (e.g. formula disbursement), and community level. All of which decreased the odds of effecting change.

While this study suggests exclusive breastfeeding is one factor that can reduce risk for early childhood overweight and obesity, the challenges faced in both private and public pediatric health care may conspire against promoting this practice. Exclusive breastfeeding in a sample of WIC infants was effective in reducing risk for overweight/obesity at age three years. These families manage significant challenges as well as represent different ethnic/racial groups. Using the person-centered, LCHD model, providers collaborate with patient/client in designing attainable health goals based on information relevant to their life and needs (Halfon, and Hochstein, 2002). Initiating and sustaining breastfeeding in the first few weeks can be considered the first post-partum step toward achieving exclusive breastfeeding.

Interdisciplinary collaboration among providers of primary health care services for pregnant and post-partum women and infants, along with delivery and newborn hospital services, would lend the additional support needed for initiating and sustaining breastfeeding in the first few weeks post-partum. Evidence-based information on exclusive breastfeeding's benefits during prenatal visits, evidenced-based support for establishing lactation and breastfeedomg during immediate post-partum care, as well as during newborn pediatric care visits provides a supportive framework within which to establish exclusive breastfeeding. Prenatal/childbirth classes represent opportunities for improving understanding of the benefits of exclusive breastfeeding. Successful, exclusive breastfeeding during the first month can be used as a platform for extending exclusive breastfeeding as well as discussion of future healthy choices during early infancy.

The definition of exclusive breastfeeding also needs clarification. The challenges of initiating and establishing breastfeeding during the first few weeks may require occasional supplemental feedings. Once sufficient supply is established, and a mother continues with exclusive breastfeeding, then this should meet the definition of exclusive breastfeeding. In this study, infants who received a supplemental feeding in the first few weeks of life were categorized as not exclusively breastfed. A mother may have offered supplemental feedings in the first two weeks to augment breastfeeding temporarily, but then was able to continue exclusively breastfeeding once lactation and nursing were well established. At what point does supplemental feeding interfere with benefits of breastfeeding? The question of how and when to use supplemental feeding are questions providers will want to understand in order to provide informed care.

Research. A life-course approach focuses research on the relationship between a child's health trajectory and life events, thereby identifying areas for potential intervention as well as prevention. The intergenerational, biophysical, developmental, and socio-economic perspective of the life-course approach encourages interprofessional collaboration. Considering the child, from the combined perspective of related disciplines, produces a comprehensive understanding of why certain phenomena occur and informs collaborative practice, education, and policies. The effect of such coordinated work is a more efficient and effective pediatric health care system and ultimately a healthier child population.

The results of this research project indicated that the longer an infant exclusively breastfeeds, the lower their risk for overweight/obesity at three years of age. The results also indicate pre-gestational, gestational, and early childhood factors contribute to the level of risk for early childhood overweight/obesity. Interdisciplinary research can identify collaborative interventions along a child's health trajectory, beginning with the health trajectory of the mother/family.

Results also suggest the need for further investigation of additional early life factors that influence risk for childhood overweight/obesity. Longitudinal analysis can reveal temporal associations that cross sectional studies lack. Henly, Wyman, and Findorff (2011) presented a compelling argument for longitudinal designs to conduct interdisciplinary health trajectory research. Expanding health trajectory science informs practice that considers both the immediate effect of interventions as well as the long-term effect of that intervention.

Policy. The implications of this study have relevance for professional practice policies as well as state and federal policies. Professional nursing practice policy implications focus on the role of professional associations to develop collaborative programs that inform and establish interdisciplinary strategies. For example, professional associations representing neonatal, pediatric, adult, and obstetric/gynecological nurses/nurse practitioners would consider the life trajectory from the pre-gestational health of the mother through early childhood and develop education, practice, and regulatory initiatives.

Current U. S. formula purchase trends are an example of the challenge to design effective state and federal nutrition policies. Oliveira and Frazão (2009) reported that in 2009 all most half of all U.S. infants participated in WIC programs. The following year, Oliveira, Frazão, and Smallwood (2010) reported that between 57 and 68 percent of all infant formula, sold in the U.S. was purchased by state WIC programs. In addition, states learned to leverage their purchase of infant formula to reduce operating costs, which allowed them to transfer those saving to providing services to more women, infants, and children.

A study that evaluated trends in childhood obesity among families participating in federally funded food assistance and nutrition programs found no difference in BMI between children two to four years of age who participated in WIC and those eligible but not participating in WIC (Ver Ploeg, Mancino, Lin, & Guthrie, 2008). One interpretation is that WIC programs do not contribute to the rise in rates of obesity among children in WIC. Another interpretation is that WIC has an opportunity to improve the nutritional status, and needs supportive, informed policies to achieve that goal since current programs are finding it difficult to affect the rate of childhood obesity in this population.

A LCHD modeled approach would support a person-centered, interdisciplinary approach to enhancing programs so that their preventative efforts have the information and resources to be effective. Collaboration with clients served by the individual WIC offices, such as in the current peer-support programs, would reveal the challenges families face as well as identify their strengths (Halfon, 2002; Kersh, Stroup, & Taylor, 2011).

Summary

In summary, results of this research project indicated that in this sample, the longer an infant exclusively breastfed, the lower their risk for overweight/obesity at three years of age. Further, exclusive breastfeeding's risk reduction effect for early childhood overweight/obesity remained significant when adjusted for other factors that contribute to risk of overweigh and obesity in these children. The results also suggested certain pre-gestational, gestational, and early childhood factors contributed to the level of risk for early childhood overweight and obesity in this sample.

The LCHD model provided the framework with which to interpret and apply these results. An interdisciplinary approach to practice, research, and policy identifies collaborative, evidence-based, and efficient interventions relevant to a child's health development trajectory, beginning with the health trajectory of the mother. A person-centered approach recognizes that building individual, family, and community assets supports a healthier population.

APPENDIX I

Nutrition & WIC Services
1000 SW Jackson Suite 220
Topeka, KS 66612

Kansas

Phone: 785-296-1320
Fax: 785-296-1326
www.kansaswic.org

Robert Moser, MD, Secretary

Department of Health & Environment

Sam Brownback, Governor

October 18, 2011

Patricia Franklin
College of Health and Human Services
George Mason University

Dear Patricia,

Thank you for your interest in using Kansas Pediatric Nutrition Surveillance System (PedNSS) data in your research. This letter confirms our permission for you to obtain copies of Kansas state PedNSS files from CDC. I know that you have been in communication with Karen Dalenius at CDC and will copy this letter to her.

We understand that you are most interested in those variables which describe the child's breastfeeding history as well as their growth and SES status, the record descriptors, demographic indicators, program participation, health indicators and behavior indicators. You will work with Karen Dalenius to obtain annual, unique child files with all available data items for years 2008, 2009 and 2010. You will also request that each child's identifiers and dates of birth are included to complete cohort analyses.

Although not a condition for this approval, we hope that you will let us know the results of your research using Kansas PedNSS data. I understand that if needed, we can contact you at 703.717.3456 or Pfrankl1@gmu.edu .

Best wishes in your work toward your dissertation. If you have questions for me, contact me at (785) 296-1189 or pthomsen@kdheks.gov.

Sincerely,

Patrice Thomsen

Patrice Thomsen, MS, RD, LD

C: Karen Dalenius, David Thomason, Patricia Dunavan

APPENDIX II

GEORGE MASON UNIVERSITY

Office of Research Subject Protections

Research Hall
4400 University Drive, MS 6D5, Fairfax, Virginia 22030
Phone: 703-993-4121; Fax: 703-993-9590

TO: Kathleen Gaffney, College of Health and Human Services

FROM: Aurali Dade
Assistant Vice President, Research Compliance

PROTOCOL NO.: 8163 Research Category: Doctoral Dissertation

PROPOSAL NO.: N/A

TITLE: Exclusive breastfeeding duration in relationship to infant weight gain and obesity up to 3 years of age

DATE: June 13, 2012

Cc: Patricia Franklin

Under George Mason University (GMU) procedures, this project was determined to be exempt by the Office of Research Integrity & Assurance (ORIA) since it falls under DHHS Exempt Category 4, research involving the collection or study of existing data, documents, records, pathological specimens or diagnostic specimens.

You may proceed with data collection. **Please note that all modifications in your protocol must be submitted to the ORIA for review and approval prior to implementation.** Any unanticipated problems involving risks to participants or others, including problems regarding data confidentiality must be reported to the GMU ORIA.

GMU is bound by the ethical principles and guidelines for the protection of human subjects in research contained in The Belmont Report. Even though your data collection procedures are exempt from review by the GMU IRB, GMU expects you to conduct your research according to the professional standards in your discipline and the ethical guidelines mandated by federal regulations.

Thank you for cooperating with the University by submitting this protocol for review. Please call me at 703-993-5381 if you have any questions.

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CURRICULUM VITAE

Patricia D. Franklin graduated from Salve Regina College with a Bachelor of Science (B.S.) Degree in 1975. While working at Georgetown University Hospital she enrolled in a Master of Science (M.S.N.) in Nursing and Pediatric Nurse Practitioner (PNP) certificate program at The Catholic University of America, which she completed in 1980. Ms. Franklin worked as a PNP in two private, pediatric practices in the Washington, D.C. metropolitan area and served on state, regional, and national professional and civic committees. In 1997, she assumed the role of president of the National Association of Pediatric Nurse Practitioners (NAPNAP) for a 1-year term. In 1999, Ms. Franklin shifted from the primary clinical setting to program development and management. From 2001 to 2010 she served as program manager of the John A. Hartford Foundation funded Building Academic Geriatric Nursing Capacity program, a multi-year, multi-million dollar grant awarded to the American Academy of Nursing. Currently she works with George Washington University's School of Nursing designing and implementing a program evaluation project for a multi-year Human Resource Service Administration (HRSA) grant-funded project. She also works with two George Mason University senior research faculty as a research assistant on a new grant funded project exploring childhood obesity.

EDUCATION

2007 – 2013	Ph.D., George Mason University, College of Health and Human Services, Fairfax, Virginia
1978 – 1980	M.S.N., Catholic University, Washington, D.C.
1971 – 1975	B.S., Salve Regina College, Newport, Rhode Island

EMPLOYMENT

2012 – Present	George Mason University College of Health and Human Services, Fairfax, Virginia Research Assistant
2011 – Present	Washington Area Geriatric Education Consortium Center, Washington, DC Evaluation program design and management consultant

2001 – 2010	American Academy of Nursing, Washington, DC Program Manager; Building Academic Geriatric Nursing Capacity www.geriatricnursing.org
1999 – 2001	American Nurses Association, Washington, DC Senior Staff Specialist
1998 – 1999	The University of Virginia Clinical Preceptor for Graduate PNP Students
1990 – 1999	The Catholic University of America Clinical Preceptor for Graduate PNP Students
1988 – 1999	Alexandria - Lake Ridge Pediatric Centers, Alexandria, VA Pediatric Nurse Practitioner
1980 – 1986	Drs. C. Eve J. Kimball and Pamela G. Parker, Silver Spring, MD Pediatric Nurse Practitioner
1975 – 1981	Georgetown University Hospital, Washington, DC Staff nurse; general, intermediate and intensive care pediatric units

PROFESSIONAL ACTIVITIES AND MEMBERSHIP

2011	George Mason University College of Health & Human Services Leadership Academy Planning Committee
2010 - Present	Sigma Theta Tau International Honor Society of Nursing member
1980 – Present	National Association of Pediatric Nurse Associates and Practitioners (NAPNAP) member
1998 – 1999	Editorial Board Member; Journal of Child and Family Nursing
1998 – 1999	Member; NAPNAP Foundation Board
1998 – 1999	Past – President; NAPNAP
1997 – 1998	President; NAPNAP
1997 – 1999	Pediatric Pain Awareness Initiative (PPAI) Board Member
1997 – 1999	NAPNAP's Representative to the National Council of State Boards' of Nursing's Advance Practice Nursing Task Force on Multistate Licensure

1996 – 1997	President – Elect; NAPNAP
1992 – 1994	NAPNAP Membership Chair / Chapters' Coordinator
1990 – 1992	Treasurer; Maryland-Chesapeake Chapter, NAPNAP; managing operational budget and research fund
1987 – 1988	Member; NAPNAP's Task Force on Liability/Malpractice Insurance
1985	Nurse in Washington Internship Program (First Class)
1984 – 1986	NAPNAP's representative to the Nurses Coalition for Legislative Action, Washington, DC
1984 – 1985	President; Maryland-Chesapeake Chapter of NAPNAP
1982 – 1984	Member; Maryland State Board of Examiners of Nurses' Peer Review Committee
1982 – 1984	Chairman; Maryland-Chesapeake Legislative Committee
1980 – 1984	Member; NAPNAP Legislative Committee
1980 – 2000	Charter and active member; Maryland-Chesapeake Chapter of NAPNAP

PUBLICATIONS

Abood, S. & Franklin, P. (2000). Issue update: Why care about medicare reimbursement? *American Journal of Nursing*, *100*, 69-72.

Barron McBride, A., Fagin, C. M., Franklin, P. D., Quach, L. B. & Huba, G. J. (2006). Developing geriatric nursing leaders via an annual leadership conference. *Nursing Outlook, 54*, 226 -230.

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Franklin, P. D., Archbald, P. G., Fagin, C. M., Sofaer, S., Galik, E., Siegel, E. & Firminger, K. (2011). Building Academic Geriatric Nursing Capacity (BAGNC): Results after the first 10 years and implications for the future. *Nursing Outlook, Jul; 59*, 198-205.

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Kitsantas, P., Gaffney, K. F., Bunchc, S. & Franklin, P. (2011). Maternal race, weight for gestational age, and infant survival. *Journal of Neonatal-Perinatal Medicine, 4,* 353–361.

Mackin, L.A., Kayser-Jones, J., Franklin, P. D., Evans, L., Sullivan-Marx, E. & Herr, K. (2006). Successful recruiting into geriatric nursing: The experience of the John A. Hartford Foundation Centers of Geriatric Nursing Excellence. *Nursing Outlook, 54*,197-203.

SPECIAL ISSUE EDITOR

Fagin, C. M., Huba, G. J., & Franklin, P. D. (2006). *Nursing Outlook. 54*,169-253.

Archbold, P. G., Franklin, P. D., & Watman, R. (2011). *Nursing Outlook*. *59*,182- 251.

POSTER PRESENTATIONS

3.25.2011 Franklin PF, Gaffney K, Kitsantas P, Nicogossian A. (2011, March). NURS 998: Dissertation Proposal Development Examining breastfeeding intensity and weight gain patterns. Poster session presented at the George Mason University; College of Health and Human Services Research Day. Fairfax, VA.

10.29.2011 Franklin PF, Gaffney K, Kitsantas P, Nicogossian A. (2011, March). NURS 998: Dissertation Proposal Development Examining breastfeeding intensity and weight gain patterns. Sigma Theta Tau International 41st Biennial Convention Meeting; Grapevine, TX.

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