MATERNAL FEEDING BEHAVIOR ASSOCIATED WITH INFANT WEIGHT GAIN IN EARLY INFANCY

By

Lisa R. Singleterry

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ABSTRACT

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Background/Purpose: Childhood obesity is a serious long-term risk factor for a variety of illnesses and generates higher health care cost in the United States. In turn, infant overweight is a risk factor for childhood obesity, and nearly 11% of U.S. infants are overweight. Because infant weight is nutrition dependent, maternal responses to infant feeding cues in the maternal-infant feeding interaction is a starting point in understanding influences on infant overweight. Yet, there are few studies focusing on how maternal responsiveness in the feeding interaction is associated with rapid weight gain (RWG). The primary purpose of the study was to determine to what extent maternal responses to infant feeding cues are associated with weight gain patterns in infants between birth and 6 months of age. **Framework**: The conceptual framework for this study used an adapted version of Barnard Parent/Caregiver Interaction model, a theoretical framework that explains the mother-infant interaction process. **Specific Aims:** (1) Determine to what extent maternal responses to infant feeding cues are associated with weight gain in infants between birth and 6 months. (2) Determine to what extent maternal characteristics (age, depressive symptomatology, education, and feeding method) are associated with maternal responses to infant cues. (3) Determine to what extent infant characteristics (age, sex, and temperament) are associated with maternal responses to infant cues. **Methods**: This study was an analysis of data from the first data collection point of the *Healthy Babies through Infant Centered Feeding (USDA 2009-55215-05220*) study. The study sample included all mother-infant dyads with complete Time 1 data entries between January 2010 and May 2011. A total of

129 mother-infant dyads were examined for this study. **Results**: (1) The proposed regression model using maternal responses to infant feeding cues and maternal and infant characteristics during the maternal-infant interaction did not predict infant weight gain; however, using logistic regression and RWG as the dichotomous dependent variable, a minimally significant result (p = .048) was seen using the proposed model to predict the odds of RWG. (2) The regression model using the proposed maternal characteristics explained 14% of the variability in Nursing Child Assessment Satellite Training Tool Caregiver Contingency Subscale (NCAFScc) scores. Maternal responses to infant feeding cues were observed less often in maternal-infant interactions where the feeding method used was a bottle. Maternal characteristics of age, education, and postpartum depressive symptomatology were not significant predictors within the regression model. (3) The regression model using the proposed infant characteristics was not found to be significant. Two characteristics, infant age and infant temperament (negative affect), were significant. As infant's age increased, NCAFScc scores declined, and as scores on the Infant Behavior Questionnaire -negative affect scale increased, NCAFScc scores declined. **Implications:** Nurses can be influential in the process of infant weight tracking and bottle-feeding education. Careful tracking of infant weight gain in comparison to the World Health Organization infant growth standard during the first 6 months of life by health care providers is a key element in the overall risk assessment to reduce the prevalence of childhood obesity. Nurses need to acknowledge that a majority of mothers will transition to bottle-feeding in the first few months of an infant's life. Along with the breastfeeding initiative already in place, a tandem initiative to support mothers while they start or transition to bottle-feeding is recommended, according to the findings of this dissertation, so mothers remain responsive to their infant's feeding cues.

DEDICATION

This dissertation is dedicated to all the mother-infant dyads who welcomed us into their homes and shared their feeding interaction with us.

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LIST OF ABBREVIATIONS

AAP	American Academy of Pediatrics
BMI	Body-mass-index
CDC	Centers for Disease Control
CVR	Covariance Ratio
EPDS	Edinburgh Postnatal Depression Scale
EPDS-3	Edinburgh Postnatal Depression Scale – 3-item scale
HRSA	Health Resource and Services Administration
IBQ	Infant Behavior Questionnaire
IBQ-EC	Infant Behavior Questionnaire Effortful Control Subscale
IBQ-NA	Infant Behavior Questionnaire Negative Affect Subscale
IBQ-R	Infant Behavior Questionnaire-Revised
IBQ-S	Infant Behavior Questionnaire-Surgency Subscale
NCAFS	Nursing Child Assessment Feeding Scale
NCAFS/NCAST-F	Nursing Child Assessment Satellite Training Tool Feeding Scale
NCAFScc	Nursing Child Assessment Satellite Training Tool Caregiver Contingency Subscale
NCAST	Nursing Child Assessment Satellite Training Program
NHANES III	National Health and Nutrition Examination Survey
NIFA	National Institute of Food and Agriculture
PCI	Parent-Child Interaction
PCI-F	Parent-Child Interaction-Feeding tool
PPD	Postpartum Depression

RWG	Rapid Weight Gain
SPSS	Statistical Package for the Social Sciences
T1	Time One
UNICEF	United Nations International Children’s Emergency Fund
USDA	United States Department of Agriculture
WAP	Weight-for-age Percentile
WAZ	Weight-for-age Z-scores
WHO	World Health Organization
WIC	Special Supplemental Nutrition Program for Women, Infant, and Children

Chapter 1

Background and Significance

The purpose of this study was to determine to what extent maternal responses to infant feeding cues are associated with weight gain patterns in infants between birth and 6 months of age. In chapter 1, the problem statement, purpose, background and significance, aims, definition of study variables, and summary are discussed. Chapter 2 introduces the theoretical framework guiding the study. A literature review of the study concepts is presented in chapter 3. Chapter 4 outlines the study methods and chapter 5 consists of the data analysis. Finally, a discussion of the findings completes the dissertation in chapter 6.

Literature has suggested that a reduction in the quality of maternal responsiveness to infant feeding cues, which are observable in maternal-infant feeding interactions, is associated with infant overweight (Barnard et al., 1989; Dennison, Edmunds, Stratton, & Pruzek, 2006; Dubois & Girard, 2006; Goodell, Wakefield, & Ferris, 2009; Sacco, Bentley, Carby-Shields, Boeja, & Goldman, 2007). Responsiveness is a complex construct involving the maternal thought and decision-making process whereby the mother acts on infant communication of hunger and/or satiety cues. The measurable components of this construct are the observable maternal responses and infant cues during the maternal-infant feeding interaction. Maternal responses have been described as the mother's positional, verbal, visual, and/or tactile answers or reactions, which are contingent with infant feeding cues–such as crying, babbling, or falling asleep–during the feeding interaction (Aboud, Shafique, & Akhter, 2009; Ainsworth, 1969b; Donovan & Leavitt, 1978). The quality of maternal responsiveness to infant feeding cues is critically important; responsiveness serves as the foundation for the development of healthy infant eating patterns and early infant weight gain that follows patterns recommended by the World Health Organization (WHO) growth standard (Johnson & Birch, 1994; Pridham, Lutz, Anderson, Riesch, & Becker, 2010; Sacco et al., 2007). The focus of this study was to explore the association between maternal responses to infant feeding cues and early weight gain of infants between birth and 6 months, in an effort to identify risk factors to reduce the incidence of childhood obesity.

Early infant weight gain is documented on infant growth charts as a series of curves that represent percentile distribution of infant weight-for-age standards. Infant weight has been defined as “too large” when the weight-for-age percentile (WAP) is at or above the 85th percentile growth curve line and has been described as being “at risk” for childhood obesity (Ogden & Flegal, 2010). Infant weight gain that is “too rapid,” or rapid weight gain (RWG), has been described as a greater than expected change in weight-for-age measures between two separate points in time (Ekelund et al., 2006; Ong, Ahmed, Emmett, Preece, & Dunger, 2000). Infant weight gain z-scores that are “greater than 0.67” are considered clinically significant (Ong et al., 2000, p.969). Standard scores or z-scores are used so an infant weight can be directly compared to population averages, in this case, the WHO infant growth standard curves (Stommel & Wills, 2004).

Early infant weight gain should follow a specific pattern that has been laid out since 1977 by the Centers of Disease Control (CDC) in the form of infant growth curves based on population survey data (CDC, 2000). Current recommendations from the CDC (2010) are that the 2006 WHO growth curve standard be used as a comparison for growth in infants from birth to 24 months of age. “Average” infant weight has been defined as falling between the 3rd and 97th percentile lines on the WHO infant growth standard. Two weight-related risk factors for future childhood obesity, recognizable when comparisons are made to the WHO growth standard, have been identified in the literature: (a) infants who follow a weight gain pattern at or above the 85th percentile, and (b) infants who gain weight too rapidly (Baird et al., 2005; Mennella, Ventura, & Beauchamp, 2011; Monasta et al., 2010; Monteiro & Victoria, 2005; Ong & Loos, 2006; Stettler, Kumanyika, Katz, Zemel, & Stallinga, 2003).

The literature has suggested that infant feeding practices may be one of the causative factors of RWG (Baird et al., 2005; Ong & Loos, 2006; Settler et al., 2003). The hypothesis of this study is that infants who gain weight too rapidly in the first six months of life will tend to have mothers who are less responsive to their infants' feeding cues. If true, the findings from this study could provide a basis for targeting specific maternal responses to infant feeding cues that can be modified to support infant weight gain that follows the recommended WHO standard between birth and 6 months.

The sample for this study was from "Healthy Babies through Infant Centered Feeding" *(USDA 2009-55215-05220*), which was a longitudinal, randomized-cohort intervention study designed to support maternal responsiveness, feeding style, and feeding practices as lower-income mothers transitioned to feeding their infant solid foods during the first year of life (Horodynski et al., 2011). Analysis was done on baseline data only for those Healthy Babies participants for whom data collection was complete as of May 2011.

Statement of the Problem

The term *obesity* has not routinely been used to describe weight issues in infancy because the body-mass-index (BMI) is not calculated for that age group. In adults, obesity has been defined as a BMI of 30 or greater. In children (aged 2 to 19), comparisons are made to a BMI-for-age and sex-specific growth curve. A child with a BMI measure above the 95the percentile on his or her BMI-for-age and sex-specific comparison curve is considered obese (Ogden & Flegal, 2010). In 2007, 32% of children (aged 2 to 19) had BMIs at or above the 85th percentile on their comparison curves (considered overweight) and 17% had BMIs at or above the 95th percentile their comparison curves (considered obese). Prevalence of obesity in childhood has more than tripled since 1980, with higher numbers of obese children seen in lower-income populations (Ogden et al., 2006; Ogden, Carroll, Curtain, Lamb, & Flegal, 2010). The overall prevalence of obesity in children aged 2 to 5 years was 10%, whereas the prevalence of obesity of children aged 2 to 5 years in lower-income families was 14% (CDC, 2011; Ogden & Flegal, 2010). Approximately 10% of infants and toddlers under the age of 24 months were reported to be at risk for obesity in 2010 because their WAPs were at or above the 95the percentile of the comparison curves (Ogden et al., 2010). In addition, it has been estimated that as many as 25% of infants gain weight too rapidly during their first two years of life and subsequently remain heavier at age five and beyond (Ekelund et al., 2006; Ong & Loos, 2006). These childhood numbers will translate into even higher obesity rates among U.S. adults, which are currently reported to be at 34% (CDC, 2011; Flegal, Carroll, Ogden, & Curtain, 2010).

Obesity at any age increases the likelihood of the cardiovascular risk factors of high cholesterol and high blood pressure, as well as bone and joint problems, diabetes, stroke, and several types of cancer (CDC, 2010; Paul et al., 2009). As a result, the financial burden of obesity is equal to 10% of the U.S. health care spending or an estimated $147 billion in 2008 (Finkelstein, Trogdon, Cohen, & Dietz, 2009). The 2007 Institute of Medicine report on *Progress in Preventing Childhood Obesity* recommended improvement of dietary patterns and activity levels of young people, but there was limited consideration given to infant growth during the foundational period between birth and 6 months (Koplan, 2007). Research and development aimed at reducing weight-related risk factors for childhood obesity through interventions for infants are needed.

Two weight-related risk factors in early infancy that have been associated with childhood obesity are RWG and weight at or above the 85th percentile. Early infant weight gain is nutrition-dependent (Denniston, 1994). Research has supported the theory that, if infants are exposed to unhealthy feeding practices and, in turn, produce higher weight gain, these infants are at risk for obesity later in life (Paul et al., 2009; Stettler et al., 2009; 2002; Thompson et al., 2009). Specifically, researchers have identified RWG between birth and 6 months as a predictor of obesity later in life (Gillman, 2010; Goodell & Wakefield, 2009). These researchers have called for the identification of risk factors contributing to RWG, citing in particular, identification of unhealthy infant feeding practices that can lead to a pattern of higher weight gain.

Infant feeding practices are multidimensional interactions between mother and infant (Wojnar, 2008). The mother-infant interaction has been well-established in attachment research (Ainsworth, 1969b; Goldsmith et al., 1987). Moreover, it is known that both infant and maternal characteristics are factors that influence this interaction between mother and infant (Barnard et al., 1989). Maternal characteristics include age, education, postpartum depressive symptomatology, and feeding method; infant characteristics include age, sex, and temperament (Barnard et al., 1989; Faith & Hittner, 2010; Seifer & Schiller, 1996; Sumner & Spietz, 1994). Although the feeding interaction has been used to study the mother-infant interaction, the main focus has been on attachment and not early infant weight gain.

For the purpose of this study, an understanding of the maternal-infant feeding interaction was guided by the Barnard Parent-Child Interaction Model (PCI), a theoretical framework that explains the maternal-infant interaction process. Specifically, maternal responses to infant feeding cues in lower-income, mother-infant dyads were measured for their association with infant weight gain. Research studies examining RWG and maternal responses to infant feeding cues are limited. However, studies that focus on infant overweight have suggested that overall patterns of maternal feeding behavior differ in degree of responsiveness and control (Baumrind, 1966; Johnson & Birch, 1994; Sacco et al., 2007). This suggests a possible association between the quality of maternal responses to infant feeding cues and early infant weight gain patterns that do not follow the growth standard proposed by the WHO. If an association does exist between these early infant weight gain patterns and maternal responses to infant feeding cues, then the next step is to determine whether there are specific maternal responses that can be modified through supportive nursing interventions to decrease the risk of RWG. Research is needed to examine the maternal-infant feeding interaction by measuring the association between maternal responses to infant feeding cues and weight gain patterns in infants.

Purpose

The primary purpose of this dissertation research was to determine to what extent maternal responses to infant feeding cues are associated with weight gain patterns in infants between birth and 6 months. Differences in maternal responses to infant feeding cues among a sample of lower-income mothers were examined and an evaluation was made to determine if these differences were predictive of infant weight gain patterns. In addition, maternal and infant characteristics were explored for associations with maternal responses to infant feeding cues.

Background and Significance

High infant birth weight, parental overweight or obesity, and, more recently, RWG in early infancy have been established as separate and significant risk factors for the development of both childhood and adult overweight and obesity (Niegel, Ystrom, & Vollrath, 2007). Currently, very little is known about risk factors for the development of RWG in early infancy, only that RWG is indeed a risk factor for later obesity in children and adults (Goodell et al., 2009; Monteriro & Victoria, 2005; Ong & Loos, 2006). One major concern is that an infant can experience RWG yet remain below the 85th percentile on a weight-for-age growth chart**.** For this reason, an infant at risk for later obesity because of RWG may be overlooked by practitioners, and as a result, parents may not receive the proper health-promotion counseling and education related to infant feeding early enough to have an impact on preventing infant RWG. Identifying infants at risk for future overweight and obesity as early as possible is clearly needed to impact the rising prevalence of obesity in the U.S. Given the sparse knowledge of risk factors affecting RWG in early infancy, research is needed to examine this phenomenon for plausible nursing-intervention strategies that may reduce the development of RWG during this critical period of infancy.

Growth charts. Infant weight gain is tracked on standardized growth-curve charts by plotting weight-for-age measurement (CDC, 2000; WHO, 2006). Since 1977, infant growth charts have been used as a tool to show how infant weight increases over time according to an infant's sex. The infant growth chart consists of a series of curves that represent the percentile distribution of weight-for-age in one and two standard deviations or z-scores from the mean for infants from birth to 24 months for each sex (CDC, 2011). Ideally, an infant will follow a percentile growth curve, identified from birth weight, over time, with very little change in z-scores. The WHO growth chart has been recommended as the standard of growth for infants from birth to 24 months (CDC, 2011).

Infant weight. In the literature, both continuous and categorical analyses have been used to describe infant weight gain that is faster than expected. Because there has been a lack of clarity for a conceptual definition of RWG in infancy, comparisons of research outcomes can be challenging (Montero & Victoria, 2005). However, research studies consistently have shown that compared to other infants, an infant who experiences higher than expected weight gain is between 1.17 to 5.70 times more likely to develop later obesity (Baird et al., 2005; Gillman, 2010; Stettler et al., 2003). It has been proposed that a very specific weight gain, where an infant's weight-for-age intercept increases more than one standard deviation between two separate evaluations measured categorically, is the definition of RWG (Ekelund et al., 2006; Ong et al., 2000; Stettler et al., 2003). An infant showing RWG will have a z-score that increases more than 0.67 (Ong & Loos 2006). Estimates given by Ong and Loos have calculated that approximately 25% of all infants will experience RWG at some point between birth and 2 years of age; nonetheless, no specific prevalence of RWG, as earlier defined, has been established. It has been hypothesized that RWG represents a significant number of infants who are at risk for childhood obesity, which can lead to insulin resistance, hypertension, asthma, hyperlipidemia, and cardiovascular disease later in life (CDC, 2010; Ong, 2010; Stettler, Zemel, Kumanyika, & Stallings, 2002).

Predictor variables. Researchers have proposed several possible characteristics associated with early infant weight gain patterns that do not follow the WHO standard growth curve (Baird et al., 2005; Ong et al., 2000; Stettler et al., 2002). Possible characteristics include infant feeding methods (breast milk, formula, or the early introduction of solids before the recommended age of 4 to 6 months; Krebs & Jacobson, 2003), lowered maternal responsiveness, and overfeeding. Other possible characteristics are (a) social, such as low parental socioeconomic status; (b) behavioral, such as maternal depression; and (c) infant characteristics, such as age, sex, and temperament (Lamb et al., 2010; Neigel et al., 2007; Ong, 2010). The most promising determinant of infant growth, and hence probably RWG, is nutrition regulation

(Goodall et al., 2009; Ong, 2010). Infant nutrition delivery is commonly carried out by the mother and can occur as often as 12 times in a day during early infancy (Denniston, 1994: Horodynski, Olson, Arndt, Brophy-Herb, Shirer, et al., 2007). As a result, the mother-infant feeding interaction should play a significant role in RWG (Goodall et al; Neigel et al.2007; Ong, 2010). The Healthy Babies study data was selected because the data provides an opportunity to identify whether feeding practices–measured through maternal responsiveness, feeding method, and infant and maternal characteristics–affect infant weight gain. Socioeconomic status is limited (at or below 185% of poverty) in the Healthy Babies sample of mother-infant dyads.

Research has shown that, when a mother is not responsive to infant hunger and satiation cues, the result can be higher nutritional intake (Faith, Scanlon, Birch, Francis, & Sherry, 2004; Hughes, Power, Fisher, Mueller, & Nicklas, 2005; Sacco et al., 2007). Research on maternal responsiveness has been based on classic attachment theory. According to that theory, maternal responsiveness remains the main process identified in the maternal-infant interaction (Ainsworth, 1969b; Barnard et al., 1989). In order to examine the effects of maternal responsiveness on infant weight gain, specifically RWG, the focus was on an observable maternal behavior, specifically described as positional, verbal, visual, and tactile responses contingent with infant feeding cues during the feeding interaction (Aboud et al., 2009; Ainsworth, 1969b; Donovan & Leavitt, 1978). The feeding interaction may also be influenced by maternal and infant characteristics (Barnard et al., 1989).

Significance to nursing science. One major research emphasis identified by the National Institute of Nursing Research includes identification and development of family interventions designed to sustain health-promoting behaviors and obesity prevention. The National Collaboration on Childhood Obesity Research lists both CDC and National Institute of Health commitment to community-based partnerships in childhood obesity prevention and control. In February of 2010, Michelle Obama began her “Let’s Move” campaign focused on prevention of childhood obesity, specifically targeting children 2 years of age and under (Wojcicki & Heyman, 2010). Moreover, the United States Department of Agriculture’s National Institute of Food and Agriculture has set long term goals to reduce the prevalence of overweight and obesity among children.

Nurses, as practitioners who provide supportive care to mother-infant dyads, are in a unique position to investigate current interventions and formulate new ones to help reduce risk factors related to obesity in infancy. The current study is important because it explores potential antecedent risk factors of RWG in early infancy, which is a significant risk factor for later obesity. The established dataset used in this study was uniquely suited to provide a level of stability for the following possible confounders: socioeconomic status (All mothers were low income; < 185% of poverty.), intake of solid food (Infants had not been introduced to solid foods at data collection time one.), and health status (Mothers or infants were not eligible if they were diagnosed with a chronic disease such as diabetes.).

Specific Aims.

The specific aims of this study were

1. to determine to what extent maternal responses to infant feeding cues are associated with weight gain in infants between birth and 6 months;

2. to determine to what extent maternal characteristics (age, depressive symptomatology, education, and feeding method) are associated with maternal responses to infant feeding cues; and

3. to determine to what extent infant characteristics (age, sex, and temperament) are

associated with maternal responses to infant feeding cues.

Definition of Study Variables

For the purpose of the current study, the outcome variable, infant weight gain, was defined using (a) a continuous variable indicating the relative weight gain or loss between birth and the infant's age at the first data collection, and (b) a categorical variable of RWG where infant weight z-score increased by more than 0.67 from birth to data collection time one (Ekelund et al., 2006; Ong et al., 2000; Stettler et al., 2003). Weight gain was calculated using maternal-reported infant birth weight compared to current infant weight, which was measured by a trained data collector in the mother's home.

Maternal responses to infant cues were described as positional, verbal, visual, and tactile responses contingent with infant feeding cues during the feeding interaction (Aboud et al., 2009; Ainsworth, 1969b; Donovan & Leavitt, 1978). Maternal responses were measured using a 15-item maternal-contingent response subscale from the observational Nursing Child Assessment Feeding Scale (NCAFS)/Parent Child Interaction-Feeding (PCI-F) tool (Barnard et al., 1989; Sumner & Spietz, 1994); hereafter the full scale will be referred to as the NCAFS and the caregiver contingency subscale referred to as the NCAFScc.

Maternal characteristics of age, postnatal anxiety/depressive symptomatology, education, and choice of feeding method were used in this study. Maternal age was defined as maternal-reported age in years. Maternal postnatal anxiety/depressive symptomatology was assessed using maternal self-report on the 3-item Edinburgh Postnatal Depression Scale (EPDS-3; Kabir, Sheeder, & Kelly, 2008). Maternal education was maternal self-reported using a structured categorical scale in the demographic questionnaire. Feeding method was limited to breastfeeding or bottle-feeding observed on the NCAFS.

Infant characteristics were limited to age, sex, and temperament. Infant sex was reported by the mother in the parent-study demographic questionnaire. Infant age was calculated as a continuous variable of the number of days and/or weeks between birth and the first data collection. Infant temperament was defined as difference in reactivity (Derryberry & Rothbart 1988). Temperament was assessed using the revised Infant Behavior Questionnaire (IBQ-R) which measures maternal perceptions of three higher-order temperaments–surgency, negative affect, and effortful control–using a 47-item questionnaire (Gartstein & Rothbart, 2003; Parade & Leekes, 2008).

Summary

The rationale for this chapter was to explore the problem, purpose, background and significance, and research aims of the current study. Factors affecting weight gain in infants between birth and 6 months are important phenomena with implications for the development of future obesity. Current literature has suggested that an investigation of antecedent factors associated with faster than expected weight gain in early infancy, which would identify at risk infants, should be done as early as possible. Given that infant weight gain is nutrition-dependent, it has been theorized by researchers that infant feeding practices, and specifically the maternal-infant feeding interaction, may be the best place to investigate (Baird et al., 2005; Ong & Loos, 2006; Settler et al., 2003). This study hypothesizes that lower-quality maternal responses to infant feeding may play a unique and yet undetected role in the development of faster-than-expected infant weight gain, specifically RWG. Maternal and infant characteristics known to influence maternal responsiveness were addressed. The current study provides a unique perspective and opportunity to investigate the effects of maternal responses to infant feeding cues on RWG, and it is the first step in the development of supportive nursing interventions for maternal behavior-modification related to infant feeding in reducing the risk of childhood obesity.

The conceptual framework used to guide this study will be presented in chapter 2. A review of the literature will be presented in chapter 3, describing maternal infant feeding interaction, which includes maternal responses to infant feeding cues and infant weight gain patterns. The study methods will be discussed in chapter 4, including the research design of the parent study, study sample, instruments, measurement of infant weight and data analysis plan. Study findings will be presented in chapter 5. Lastly, study results will be discussion along with implications for nursing practice and education, future research and policy in chapter 6.

Chapter 2

Theoretical Framework

While the causes of RWG in infancy are not fully understood, researchers have speculated that RWG is partially a result of infant feeding practices because infant growth is nutrition-dependent (Goodell & Wakefield, 2009; Ong & Loos, 2006). Infant feeding practices include the infant feeding process, which is defined as a complex interaction between a mother and her infant. This chapter will present the theoretical framework for this study, which proposes that the quality of maternal responses to infant feeding cues is associated with the development of RWG in early infancy. Literature that supports the development of the study framework will be reviewed. The theoretical model for maternal behavior in response to infant feeding cues will be discussed. In addition, the study framework and the proposed relationships among its concepts will be visually presented and discussed. This chapter will conclude with a summary of how, in theory, maternal responses to infant feeding cues are associated with early infant weight gain.

Framework Development

The first feeding experience for an infant takes place in various environmental contexts but contains a common element, the maternal-infant interaction (Wojnar, 2008). The quality of this mother-infant interaction has been thought to be responsible for the infant's learning of multiple social skills, such as communication, and for the development of cognitive and physical skills (Ainsworth, 1969). Although this phenomenon (mother-infant interaction) has been defined well within the literature on attachment, it is not clear how factors in the mother-infant interaction affect physical growth or weight gain in infancy.

One model, the Barnard PCI model, has described the interaction between a caregiver and child during the feeding interaction (Barnard et al., 1974). The Barnard PCI model was developed in the early 1970s, during which time research findings indicated that early infancy was a time to establish routines and positive patterns of interaction; feeding being an ideal time to establish such patterns (Barnard et al., 1989). The construction of the Barnard PCI model was based on the physical, emotional, intellectual, and social development of a child. Encompassing the overall environment of the child, along with specific characteristics of the interaction, was the goal of this model. A second goal of the PCI model was to understand the context in which the child develops (Barnard et al., 1989).

Barnard's PCI model focused on two common maternal-infant interactions: feeding and teaching. Using this model, Barnard developed two separate assessment tools and disseminated them nationally, through a satellite training program, to nurses and other health care professionals. As a result, the Nursing Child Assessment Satellite Training (NCAST) Program was established. The Healthy Babies study used the NCAFS to assess the maternal-infant feeding interaction.

In the model, Barnard identified the crucial component to be the interactive system among mother, infant, and environment. Barnard believed a deficit in one of these would ultimately affect the others. In other words, individual maternal, infant, or environmental characteristics influenced the maternal-child interaction/system and visa versa. One of the major claims of the Barnard model was that an infant's behavior changed in response to both maternal and environmental stimuli (Wojnar, 2008). This idea is important because a main assumption in this dissertation was that there is relationship between the quality of the maternal-infant feeding interaction and physical health, or in this case RWG, in early infancy.

Barnard derived her model, in part, from the systems model. The General Systems

Theory has described a system as a set of factors in an environment that affect one another to form a whole that is different from any of the parts (von Bertalanffy, 1968). A system is an interaction of parts. The main characteristics of a system are wholeness, interdependence, self-regulation, and balance (von Bertalanffy, 1968). Barnard proposed that patterns of parent-child interactions were often linked to the child's "cognitive and linguistic competencies and to more secure attachment" later in life (Barnard et al., 1989, p. 40).

The PCI model was also derived from elements of developmental theory. There have been several general development theories dealing with complicated phenomena, such as temperament, attachment, social learning, and ecology. Developmental theories have been focused on how a phenomenon changes or progresses. There is also usually a component of learning which takes place through interaction (Merriam & Caffarella, 1999). The PCI model has focused on the infant's emotional, intellectual, and physical development (NCAST Program, 2011).

Another influential theory for the PCI model is attachment theory. Bowlby originated this theory, and Ainsworth devised a methodology to test the theory's tenets. Together, Ainsworth and Bowlby (1991) believed infants become attached to adults with consistent sensitive and responsive behavior. Barnard also believed that this was an important ingredient in the health and well-being of children (Barnard et al., 1989). The PCI model has viewed the mother-infant interaction as a system or dialog, both mutual and adaptive. The maternal-infant interaction has been further described as a dance between partners where both partners and the dialog must have certain features (Barnard et al., 1989).

The two partners in Barnard's PCI model (Sumner & Spietz, 1994, p. 8) are mother and infant. The maternal-infant interaction includes characteristics of the mother and the infant.

Maternal characteristics include the following: sensitivity to cues, alleviation of distress, and providing growth-fostering situations; infant characteristics include: clarity of cues and responsiveness to caregiver/parent. The proposed interaction between the mother and the infant can be interrupted, but no specific factors have been identified that cause the interruption. The Barnard model has origins in systems theory, developmental theory, and attachment theory, and it has included a comprehensive explanation of content with logical congruence to the nursing paradigm.

Study Framework

The PCI model provides the first step to explore the maternal-infant feeding interaction. The phenomenon of interest in this study is maternal responses to infant feeding cues, which is the observable component of maternal responsiveness, a major process of the maternal–infant feeding interaction (Pridham et al., 2010). For the purpose of this study, maternal responses to infant feeding cues have been defined as positional, verbal, visual, and tactile responses of the mother, contingent with infant feeding cues during the feeding interaction (Aboud et al., 2009; Ainsworth, 1969a; 1969b; Donovan & Leavitt, 1978). Specifically, this dissertation was focused on the feeding interaction where feeding cues are given by the infant and responses to those cues are returned by the mother (Pridham et al., 2010).

The underpinning of the main predictor variable proposed in this study came from Ainsworth and Bowlby's attachment theory and will be described in chapter 3's literature review. Ainsworth has described maternal sensitivity (used interchangeably with maternal responsiveness) as a main construct in the proximity attachment framework and indicated "the baby may signal, but the mother is responsible for responding to his signals with an increase or decrease in maternal care behavior" (1969b, p.1007). Ainsworth further has identified four major concepts in this interaction: (a) awareness of the signals, (b) an accurate interpretation of the signal, (c) an appropriate response to the signal, and (d) a prompt response to the signal. Since it was not within the scope of the Healthy Babies data to describe attitudes, beliefs, and decisions of mothers, this study focused on the observable aspect of maternal responses to infant feeding cues.

The study framework consisted of the maternal-infant interaction measured by maternal responses to infant feeding cues, maternal and infant characteristics, and the outcome variable, infant weight gain (see Figure 1). Maternal recognition or awareness, maternal interpretation, and maternal decisions to act are all antecedents of the observable maternal responses to infant feeding cues. Therefore, these aspects of the maternal sensitivity process were not identified in the visual representation of the study framework. Environmental variables, although considered important, were not the main focus of this study and were not specifically identified in the study framework. The *feeding environment* is depicted using a dotted rectangle that encompasses the maternal-infant feeding interaction and antecedent characteristics of the mother and infant. Because of limitations inherent with secondary data, maternal and infant characteristics were limited to the data available and have been shown to influence the maternal-infant feeding interaction.

The study model was an adaption of the Barnard PCI model (Barnard et al., 1974). Derivations of the observable portion of Ainsworth's (1969b) maternal sensitivity process (maternal responses to infant feeding cues), along with maternal and infant characteristics, have been shown to influence infant weight gain. The study focused solely on the bolded concepts and relationships with solid arrows. Other theoretical relationships are shown as broken lines with or without arrows and were not included in this study. The study framework showed a theoretical relationship among maternal characteristics and the maternal-infant feeding interaction, measured by maternal responses to infant feeding cues. There was also a proposed relationship between infant characteristics and the maternal infant feeding interaction. The maternal-infant interaction is depicted as being influenced by both maternal and infant characteristics. Both partners, mother and infant, were seen as important aspects of the maternal-infant interaction by the Barnard PCI model. This interactive process has been theorized to influence infant weight gain and untimely childhood obesity, which is depicted by a broken-lined propositional statement, because it was not addressed in this study (Faith et al., 2004; Hughes et al., 2005; Sacco, et al., 2007).

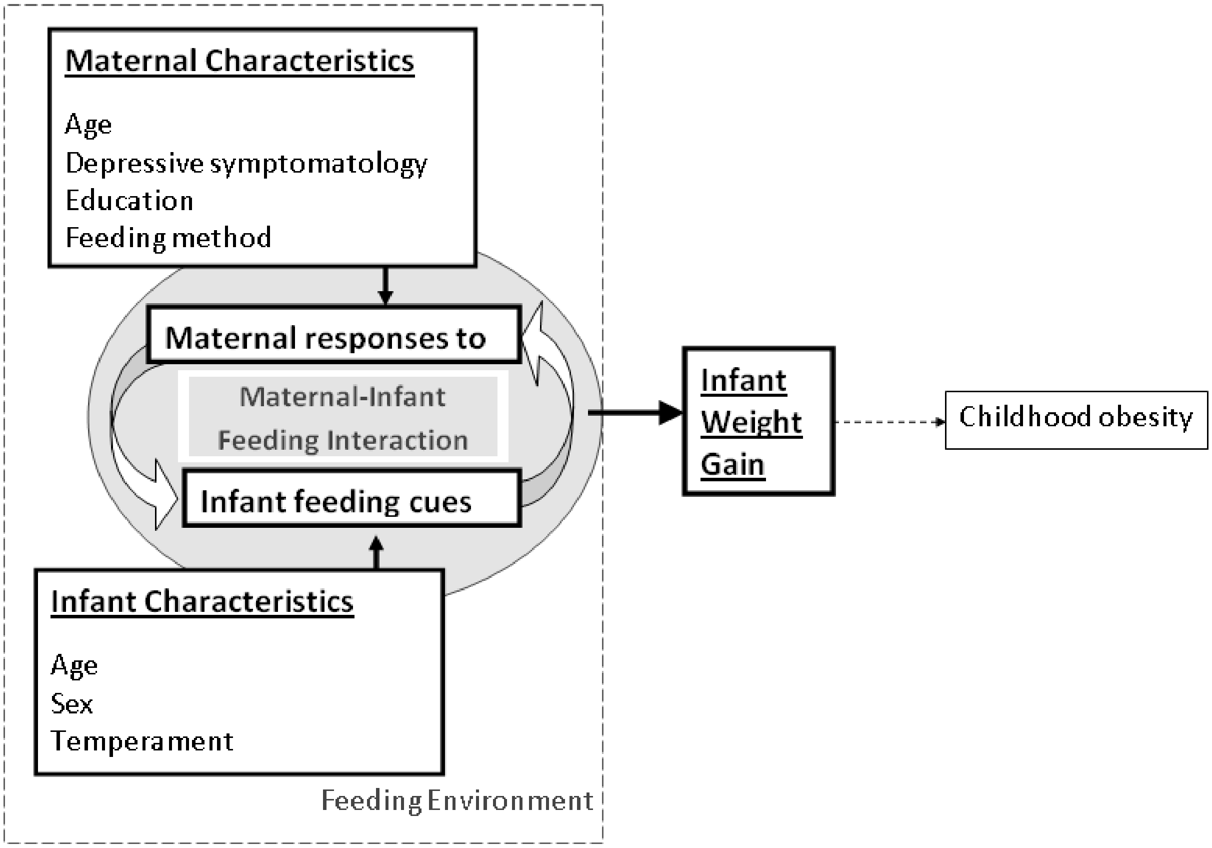

Figure 1. Study theoretical framework.

Summary

The complex relationship between mother and infant is not fully understood, especially in relation to the physical development measured as infant weight gain. One construct found in attachment theory, identified as a consistently responsive and sensitive adult (maternal sensitivity or maternal responsiveness), has been well documented as a positive influence on the social and cognitive development of an infant. Because antecedent factors influencing RWG are limited in the literature and infant feeding practices have been suggested as possible factors of influence, maternal responses to infant feeding cues is a plausible predictor variable.

One model in particular, the Barnard PCI model, was developed in response to needs of health care providers to identify infants at risk for poorer outcomes in health and well-being. The

PCI model, in turn, influenced the development of a tool measuring certain features of the maternal-infant feeding interaction. Both the PCI model and Ainsworth's definition of maternal sensitivity/maternal responsiveness were used to develop a theoretical framework for this study. Guidance in examining propositional statements between concepts was provided by the theoretical framework.

Chapter 3

Review of the Literature

The purpose of chapter 3 is to provide a review of the literature concerning the maternal infant feeding interaction, which includes maternal responses to infant feeding cues and infant weight gain patterns The review of the literature was specific to the phenomenon of interest, infant weight gain between birth and 6 months. Infant weight gain between birth and 6 months has been an outcome of interest to nurses, primary care providers, health professionals, and policy makers because it is used as an overall health indicator of infants in the United States. Infants who are overweight and/or show RWG in the first six months of life are more likely to be overweight children and adults (Butte, 2009; Dubois & Girard, 2006; Gillman, 2010; Goodell & Wakefield, 2009; Paul et al., 2009; Stettler et al., 2009; 2002; Thompson et al., 2009). Although both overweight status and RWG have been identified as risk-factors for childhood obesity, causes of these risk factors are limited in the literature. In chapter 2, a theoretical framework was proposed to explain characteristics of infant feeding practices that impact infant weight gain. The maternal-infant interaction has been shown to affect infant social, cognitive, and physical development but not specifically as a factor affecting RWG. Thus, there has been a gap in the literature in regard to maternal and infant characteristics that influence RWG from birth to 6 months. The maternal-infant feeding interaction, which includes the key characteristic of contingent maternal responses to infant feeding cues, along with associated maternal and infant characteristics, were proposed by this study to influence infant weight gain between birth and 6 months.

This chapter will begin with a discussion on infant growth and measurement and comparisons of standardized infant growth charts. Definitions of obesity, infant overweight, and

RWG will be presented and clarified. Next, concepts identified in the theoretical framework presented in chapter 2 will be reviewed. The study framework hypothesized a link between infant weight gain and infant feeding practices, which includes maternal responses to infant feeding cues and maternal and infant characteristics. This chapter will end with the conclusion and significance gained from a review of the literature.

Outcome Variable: Infant Weight Gain

Infant growth and weight gain. The word *infant* has generally been used to describe a very young child between 1 month and 12 months of age that can neither walk nor talk (Merriam-Webster, 2003). Growth is the process of becoming larger and more mature. On average, an infant will weigh 3.3 kg (7 lb. 8 oz.) at birth (Ball, Bindler, & Cowen, 2012). It is common for infants to lose a few ounces during the first few days of life as they adjust to sucking, swallowing, and digesting (Wong, Hockenberry, & Wilson, 2003). After this first week, infant growth becomes more rapid. Birth weight generally doubles by about four months and triples by 12 months. On average, an infant will gain 1 kg (2.2 lb.) per month, or approximately 30 g (1 oz.) per day (Ball et al., 2012; Pinyerd, 1992). Pinyerd (1992) also has noted gender (generally referred to as sex) differences associated with birth weights, “the newborn male averages 0.35 inches longer, is 150 grams heavier…” (p. 303). To measure infant growth both the CDC (2000) and WHO (2006) have developed age- and sex-specific growth standard charts to show the average range and rate of growth for height (recumbent length in infants), weight, and head circumference.

Infant weight-for-age, sex-specific charts. Identification of infant growth that is considered “abnormal” implies some way of comparison with infant growth that is “normal.” Generally, a growth chart is constructed by averaging the growth data of a large number of subjects to use for comparison. Common body measurements, or anthropometric measures, of infants include weight-for-age, recumbent length-for-age, and head circumference. Two different approaches can be taken when growth charts are developed. In a descriptive approach, no exclusion criteria are followed. Thus, infants who may be unhealthy or receiving poor nutrition and healthcare are included in the reference (Mei et al., 2008). This approach is different when developing a standard growth curve. To develop a standard growth curve, a prescriptive approach is used to include only mother-infant dyads who adhere to established feeding and health care recommendations (Mei et al., 2008). The reference population is an important consideration when choosing an infant growth chart. Fundamental differences exist between the CDC and WHO growth charts because they use different reference population (Mei et al., 2008).

CDC growth charts. Prior to 1977, various growth charts existed based on segments of the U.S. population. In 1949, Meredith published a "physical growth record" in the *American Journal of Public Health*. The Harvard growth curves, published in growth and development textbooks of the 1950s and 60s were based on a reference population of Boston children from 1930 to 1956 (de Oni & Yip, 1996). In an effort to increase generalizability of the growth curves to all segments of the U.S. population, the CDC and National Centers for Health Statistics (NCHS) joined forces and used cross-sectional data to construct a contemporary reference based on population reference data in 1977 (CDC, 2010). However, the 1977 NCHS/CDC growth curves for infants (aged 0-23 months) were developed using a segmented population from the Fels Research Institute Longitudinal Study from 1929 to 1975; infants were primarily formula fed, socioeconomically advantaged, and Caucasian (de Onis & Yip, 1996).

In 2000, the CDC revised the 1977 growth charts (Kuczmarski et al., 2000). The data used to develop the revised growth curve charts were from nationally representative U.S. survey data. Specifically, infant growth curve charts were improved by using a wider aggregate which included racial/ethnic diversity and combined the size and growth patterns of breastfed and formula-fed infants in the United States (Kuczmarski et al., 2002). Data from the 1976 to 1980 and 1988 to 1994 National Health and Nutrition Examination Survey (NHANES) III were both used. The NHANES III oversampled infants and children 2 months to 5 years of age (Kucsmarski et al., 2000). Experts in child growth and growth charts, biostatisticians, pediatric practitioners, and applied public health nutritionists worked together to develop a chart that represented aggregate infant growth from 1963 to 1994 (Kuczmarski et al., 2000). In addition, improved statistical techniques were used to produce smoothed percentile curves that transitioned better between infant and child growth charts (Kuczmarski et al., 2002). The resulting CDC growth chart has been recommended as a growth reference because it describes how infants and children grew between 1963 and 1994. No further revisions have been made, to date, related to the 2000 CDC growth charts.

WHO growth charts. A global growth standard, describing a growth curve that would represent the way all infant should grow, was developed by the WHO in 2006, based on the Multicenter Growth Reference Study results between 1997 and 2003 (2011). According to the WHO Child Growth Standard summary, the reference population was limited to 8,500 healthy, breastfed infants of nonsmoking mothers in six countries: Brazil, Ghana, India, Norway, Oman, and the U.S. (CDC, 2011). To develop the growth curve charts, WHO statistical experts utilized the Least Median Squares-based method to smooth percentile curves; this was the same statistical method used to develop the 2000 CDC chart. Thus, the difference between the 2000 CDC and 2006 WHO growth curve charts was based primarily on largely a reflection of their reference population (Mei et al., 2008; WHO, 2011). The reference population is an important consideration in this study because the literature has indicated that slower growth occurs in breastfed infants between 3 and 6 months (Grummer-Strawn, Reinold, & Krebs, 2010). The WHO growth chart has represented a standard or ideal infant growth, regardless of race, ethnicity, and nationality. The WHO growth chart also has represented the current evidence-based-practice recommendations of the American Academy of Pediatrics (AAP), CDC and WHO, such that infants should be breastfed exclusively for the first 6 months of life (Krebs & Jacobson, 2003). The WHO Infant Growth Standard has taken a prescriptive approach in describing how infants should grow.

The CDC recommends using the 2006 WHO Infant Growth Standard for growth comparison in infants less than 24 months of age in the United States (Grummer-Strawn et al., 2010; Mei & Grummer-Strawn, 2011). The WHO weight-for-age growth standard consists of five curves labeled as the third percentile, 15th percentile, 50th percentile, 85th percentile and the 97th percentile. For male infants, the third percentile line begins at a birth weight of 2,500 g; the 97th percentile curve begins at a birth weight of 4,400 g. According to the WHO infant growth standard chart (2006), 95% of male infants will weigh between 2,500 g (5 lb. 8 oz.) and 4,400 g (9 lb. 11 oz.).

An infant will generally follow the percentile line pattern from the weight-for-age, sex-specific growth curve based on birth weight. For example, a male infant weighing 3,090 g at birth is plotted on the WHO weight-for-age, sex-specific growth chart and is shown to be at the 29th percentile; generally all subsequent weights will be plotted at or near that 29th percentile (Ball et al, 2012, p. 344). Anthropometric measures of infant growth provide pediatric practitioners with critical information of infant nutrition both past and present. The AAP has recommended the use of weight-for-age, sex-specific growth charts to screen infant growth, health, and nutrition (Nash et al., 2008; Ogden, 2004). Accurate anthropometric measures and documentation of infant growth have been recommended at birth, 1, 2, 4, and 6 months by the AAP (Krebs & Jacobson, 2003). Serial plotting of infant growth on a standard growth chart can be used to screen overall health. Growth charts have been used to identify weight-related risk factors, such as infant overweight, by comparing an infant's weight on a weight-for-age, sex-specific chart. Rapid or sustained longitudinal changes, seen in comparison to the growth standard curve or earlier percentiles, may indicate chronic disease, emotional difficulty, or nutritional intake problems (Ball et al, 2012, p. 344).

Growth charts represent the general aggregate pattern of infant weight-for-age growth from birth to 24 months and have been commonly referred to as the normal growth curve. The importance of screening infant growth stems from the fact that growth is the most valuable indicator of general health in the infant population. Each infant has his or her own individual growth pattern. Thus comparison to an average or standard growth chart and consistency of sequential measures are of critical importance in evaluating health indicators for this population (Ball, et al., 2012, p. 344; Nash et al, 2005). Growth that does not follow the typical pattern outlined by a standard infant growth chart may be pinpointing medical or nutritional problems (Nash et al., 2005).

The WHO Infant Growth Standard was chosen as the comparison chart in this study because it takes a prescriptive approach in describing how infants should grow, and it has been recommended by the CDC, thus adding to the translation of findings from this study into practice (Israel, Schultz, Parker, & Becker, 1998).

Weight-related definitions. Average infant weight gain is about 30 g per day (Ball et al, 2012; Pineyard, 1992). The focus of this study was on higher-than-expected weight gain in infancy; both overweight and RWG. However, differentiation of terms used to describe weight gain in the adult, child, and infant population is important. Second, acknowledgement and definitions associated with lower-than-expected weight gain will be briefly discussed. The main focus of this section will be on infant weight-related definitions (compared to the normal growth curve), described as both too large or too rapid, because they have been identified as weight-related risk factors for future obesity (Baird et al., 2005; Mennella et al., 2011; Monasta et al., 2010; Monteiro & Victoria, 2005; Ong & Loos, 2006; Stettler et al., 2003).

In a recent concept analysis on "childhood obesity" several terms were identified when discussing weight gain, including *overweight*, *at risk for overweight*, *adiposity, Body Mass Index (BMI)*, and *fat* (Montoya & Lobo, 2011). However, the term *obesity* was shown to mean different things in different populations. Ogden and Flegal reported that the American Medical Association expert committee redefined terminology for childhood obesity (children aged 2 to 19) in 2010. In children 2 to 19-years-old, the term obesity has been defined as a BMI-for-age that plots the 95th percentile and greater on a comparison CDC sex-specific growth chart (Ogden & Flegal, 2010, p. 1). The term obesity generally has not used to describe an infant because BMI is not calculated for children under the age of 24 months (2 years of age). The terms *high* or *at risk for overweight* or *at risk for obesity* have been used for an infant with a weight-for-age that plots at or above the 95th percentile on any standardized infant growth chart (Ogden & Flegal, 2010). A second term which has been used to describe high infant weight gain is *overweight*. In general, an infant weight graphed on a sex-specific infant growth chart at or higher than the 85the percentile is described as *at risk* for overweight (Ogden, 2010).

Another high infant weight gain category that places infants at a higher risk of developing obesity later in life is RWG. Weight-for-age changes over time. The assumption has been that weight changes will generally follow the curves of the comparison standard growth curve. Infant weight that has been described as too rapid is a higher-than-expected weight gain when compared to the standard growth curve (Ekelund et al., 2006; Ong et al., 2000). Conceptual definitions of the term RWG have varied in the literature and generally have been based on the technique used to measure the change (Baird et al., 2005; Monteiro & Victoria, 2005; Ong & Loos, 2006). Differing conceptual definitions of a term reduce the ability to compare research findings and ultimately, to translate into practice.

There were two main techniques to measure faster-than-expected weight gain found in these studies. One technique was to calculate the difference in weight for two age points divided by the time, reporting weight gain in grams per day or grams per month, and using the highest quartile as those infants showing RWG (Dennison et al., 2006; Dubois & Girard, 2006). Secondly, researchers have used the differences in weight-for-age z-score WAZ between two plotted measures (Baird et al., 2005; Monteiro & Victoria, 2005; Ong & Loos, 2006). This definition of RWG describes a very specific weight gain trajectory where an infant's weight-for-age intercept increases more than one standard deviation between two separate evaluations (Ekelund et al., 2006; Ong et al., 2000; Stettler et al., 2003). One standard deviation is equivalent to an increase or decrease of 0.67 standard deviation in WAZ calculated from sequential plots on infant growth charts (Ekelund et al., 2006; Ong et al., 2000). For example, an infant who follows the standard infant growth curve exactly (plotted weights are at the same percentile each time) would have a corresponding z-score change of zero. Infant weight gain z-scores that are "greater than 0.67" were considered clinically significant by Ong et al. (2000, p.969). Because of these differing techniques, it is challenging to determine the prevalence of RWG or compare the odds of developing childhood obesity between studies.

A second challenge in comparing studies focused on RWG is the time interval used between weight measures. Because RWG has been considered a predictor, not an outcome, most studies concerning RWG have been retrospective. Thus, the time intervals per the AAP recommendations of well-infant checks have been the most convenient to use: birth, 1 month, 2 months, 4 months, 6 months, 9 months, and 12 months (Baird et al., 2005; Krebs & Jacobson, 2003; Monterio & Victora, 2005; Ong & Loos; 2006). Generally, one time period has been used (e.g., birth to 4 months or birth to 6 months), not serial tracking of weight changes, limiting the known pattern of RWG, especially between birth and 6 months.

Although the focus of this study is infant weight gain in excess, infant growth faltering is also important to note for clarity of terms and patterns of infant growth. Inadequate growth in early childhood has been described as failure to thrive, growth faltering, weight faltering, growth retardation, and undernutrition (Hosseini, Borzouei, & Vahabian, 2011; Olsen, 2006; Raynor & Rudolf, 2000). There has been ambiguity and inconsistency in defining inadequate growth in infancy; this was noted in 1989 (Wilcox, Nieburg, & Miller) and reconfirmed in 2010 (Olsen, Skovgaard, Weile, Petersen, & Jorgensen, 2010). In general, the criteria utilized for failure to thrive has been based on weight gain: growth at or below the CDC growth reference 5th percentile or 3rd percentile on the WHO Infant Growth Standard, a reduction in growth velocity of more than two percentile lines, or being among the slowest gaining 5% (Hosseini et al., 2011, Olsen, 2006; Wilcox et al., 1989). Again, the lack of specific definition of terms reduces comparative findings and translation into practice.

In summary, this section defined terms of infant weight gain (compared to the normal growth curve). The terms used to describe infant weight-related risk factors for obesity, however, have not been clearly defined as those for children 2 to 19 years of age and adults, which are dependent on BMI calculations. There has been reluctance in the practice arena to label an infant as obese, which has lead to the use of terms such as at risk for overweight to describe an infant with a weight that is plotted on the age- and sex-specific growth chart at or above the 85th percentile. A second term, RWG, has been used to describe infant weight gain that is either (a) the highest quartile within the study sample or (b) faster than expected when compared to normal growth standards. The term, RWG, implies weight only, without consideration of other anthropometric measures, such as recumbent-length. The variability in defining RWG has made it difficult to compare studies, or define prevalence of RWG within age groups. Clear definitions for weight-related risk factors for childhood obesity, in infants' birth to 6 months, are needed.

High infant weight gain as a weight-related risk factor. Overweight may begin in infancy and continue through childhood, into adolescence and adulthood (Baird et al., 2005; Mei et al., 2003; Ogden & Fegal, 2010). In a policy statement, the AAP recommended that practitioners "identify and track patients at-risk by virtue of family history, birth weight, or socioeconomic, ethnic, cultural, or environmental factors" (Krebs & Jacobson, 2003, p. 427). Furthermore, the AAP recognized infant weight plotted at or above the 85th percentile to be a risk factor for the development of childhood obesity and recommended further health supervision and counseling for those families.

The NCHS also has defined an infant weight plotted at or above the 85th percentile on a comparison growth chart as being at risk for the development of obesity (Ogden & Flegal, 2010). In a retrospective, nested case-controlled study of 8,435 children less than 5 years of age, seen over 2 years in a U.S. health clinic, 16% were identified as obese (Their weight plotted $\geq$ to the 95th percentile on the CDC growth chart; McCormick, 2010). This study also reported that 35% of infants who were obese at 6 months continued to be obese at 24 months.

In 2005, two systematic reviews of literature were published, one from England and one from Brazil, both focused on infant weight-related risk factors for childhood obesity (Bard et al, 2005; Monteiro & Victoria, 2005). Between 22 and 24 articles were identified, and a majority of the articles were the same in both systematic reviews. Baird et al. (2005) concluded that the odds ratio of developing obesity in childhood was higher for infants who showed either RWG or who were in the highest end for weight distribution. Monteiro and Victoria (2005) focused specifically on RWG and found a wide variety of definitions (The most frequent definition for RWG was a z-score change greater than 0.67 in weight-for-age.), but concluded early RWG was associated with the prevalence of obesity later in life. In more recent studies, Goodell, Wakefield and Ferris (2009) conducted a retrospective chart review to define the relationship between birth weight, RWG and early childhood obesity in 203 3-year-old, minority children. "RWG was defined as an increase in weight-for-age z-scores ≥ 0.67 standard deviations (SD) between birth and 4 months" (Goodell et al., 2009, p. 372). In this study infants, showing RWG, between birth and 1 year of age were 9 times more likely to be obese and 31 times more likely to be extremely obese at ages 24 and 38 months.

Both Ong (2010) and Goodell et al. (2009) suggested that infant feeding practices may be leading to RWG in early infancy. Ong and Loos (2006) suggested that a combination of formula feeding and early introduction of solids lead to RWG, but limited studies have focused on RWG as an outcome variable. Thus, a gap exists in the literature where RWG is used as an outcome variable, which limits knowledge related to risk-factors for RWG in infants from birth to 6 months of age.

In summary, literature has suggested that higher than expected weight gain is a strong risk factor for later obesity (McCormick et al., 2010; Mennella et al., 2011; Monasta et al., 2010;

Ong, 2010; Stettler et al., 2002). Several systemic reviews reported a positive association between higher than expected weight gain and later obesity (Baird et al., 2005; Monteiro & Victora, 2005; Ong & Loos, 2006). From the literature reviewed, it has been suggested that RWG is a predictor of later obesity, but further research is needed to identify the predictors of RWG in infancy to help reduce childhood obesity (Baird et al., 2005; Monteiro & Victora, 2005; Ong & Loos, 2006). Two characteristics identified in the literature as potentially affecting RWG or infant weight gain include socioeconomic status and infant feeding practices. Infant feeding practices include types of infant feeding (breast, formula, or age of introduction to solids and overfeeding), maternal responsiveness, and overfeeding (Baird et al., 2005; Ong et al., 2000; Stettler et al., 2002). In the next section, feeding practices identified in the study model as the feeding environment will be explored.

Predictor Variables

Infant feeding practices were defined in chapter 2 as multidimensional interactions between mother and infant (Wojnar, 2008). There are several known maternal characteristics that affect infant feeding practices, including maternal responsiveness and feeding method. The Barnard PCI model was adapted to guide this study because it identifies maternal and infant characteristics that influence the mother and infant interaction (Barnard et al., 1989). In the following section, maternal responses to infant feeding cues and maternal and infant characteristics that affect infant feeding practices will be discussed. Literature was reviewed for conceptual, theoretical, and empirical relationships and spanned several disciplines, including research from nursing, psychology, nutrition, family studies, and public health.

Maternal responses to infant feeding cues

Maternal responsiveness. Response or responsiveness has been defined as something done in reaction to something else (Merriam-Webster Collegiate Dictionary, 2003). Synonyms identified by the Encarta thesaurus associated with responsiveness were (a) *receptiveness,* defined as ready and willing to accept something such as new ideas, quick to take in new information; (b) *reaction*, described as an emotional or intellectual response that something arouses; a response to something that involves taking action, or an action taken in response to something; (c) *sensitivity,* defined as the care and understanding of needs and requirements; capacity for physical sensation or response; and lastly, (d) *awareness*, defined as having knowledge of something from having observed it or been told about it; knowing that something exists because you notice it or realize that it is happening.

The term *maternal responsiveness* and a second term, *maternal sensitivity* (often used synonymously), have been described in the psychology literature as a component of attachment theory. The term maternal responsiveness was derived from the maternal sensitivity process described by Ainsworth (1969a; 1969b) as maternal behavior elicited by her infant's behavior, such as crying. A corresponding construct, *parental sensitivity,* was described as "an adult's tendency to provide contingent, appropriate, and consistent responses to an infant's signals or needs" (Lamb & Easterbrooks, 1981, p. 127). Ainsworth identified four stages of sensitivity that were congruent with those identified by Lamb and Easterbrooks: (a) perceiving the infant's signal or need, (b) interpreting it correctly, (c) selecting an appropriate response from parent's repertoire, and (d) implementing it effectively (Lamb & Easterbrooks, p. 128). The fourth stage in this sensitivity process (implementing) was the observable responses to the infant's cues. Ainsworth described the responsiveness of the mother as a mammalian "retrieving" behavior, thought to protect the infant from danger. Further, Ainsworth described responsiveness as the observable phenomenon of maternal sensitivity: "the baby may signal, but the mother was responsible for responding to his signals with an increase or decrease in maternal care behavior" (Ainsworth, 1969b, p.1007).

In 2008, a concept analysis of maternal sensitivity defined it as "the quality of a mother's sensitivity behaviors that are based on her abilities to perceive and interpret her infant's cues and respond to them" (Shin, Park, Ryu, & Seomun, p. 307). The process of maternal sensitivity includes three stages that are challenging to measure: perception or recognition of the cue, interpretation, and decisions to respond are internal mechanisms not readily observable. The measurement of maternal sensitivity has therefore been based on observable maternal responses contingent to infant cues. Because the measure of maternal sensitivity was based on maternal responses, the term maternal responsiveness began to emerge in the literature in place of maternal sensitivity (Amankwaa & Pickler, 2007; Shin et al., 2008).

Maternal responses. Maternal responses were identified in the literature as synchronous, reciprocal exchanges or expressions between mother and infant during interactions and included a variety of descriptions, including touch, play, and talk (Aboud et al., 2009; Ainsworth, 1969b; Brown, 2007; Brown & Pridham, 2007). Responding with sensitivity, respect, warmth, appropriateness, and/or emotional availability were also common descriptors of responsiveness (Amankwaa & Pickler, 2007; Donovan & Leavitt, 1978; Pridham, Stewart, Thoyre, Brown & Brown, 2007).

In a qualitative research report regarding mothers' decisions to feed their infants, the term *maternal feeding responsiveness* was used in association with three central themes: prominence, intensity, and specificity of infant cues (Hodges, Hughes, Hopkins & Fisher, 2008). Hodges et al. (2008) asked 71 mothers of healthy term infants at 3, 6, or 12 months of age about feeding initiation and termination. A wide variety of mother-identified infant cues associated with initiation or termination of infant feeding were determined in this study, but no specific maternal feeding responses were described.

Another term similar to maternal responses, *maternal feeding behavior*, was found in the literature, but was inconsistently defined. Literature relating to premature infants described maternal feeding behavior as an adaptive mechanism to support appropriate feeding through being sensitive and responsive to an infant's cues for protection, nurturance, and comfort (Brown, 2007; Brown & Pridham, 2007; Pridham et al., 2007). These studies described, in detail, the infant's behavior and measured maternal feeding behaviors with the 14-item Parent-Child Early Relational Assessment instrument: (a) structuring a feeding and mediating the environment; (b) responding sensitively to the infant needs; (c) responding flexibly; and (d) expressing little or no negative feelings. In a study focusing on illness and convalescence of children, maternal feeding behavior was qualified as the degree of effort a caregiver applied to encourage children to eat (Bentley, Stallings, Fukumoto, & Elder, 1991). The caregiver's efforts were measured as verbally encouraging, verbally pressuring, and physically forcing the child to eat (Bentley et al., 1991). Kroller and Warshcburger (2009) used maternal feeding behavior to describe six categories of behaviors self-assessed by mothers: (a) restriction, (b) monitoring, (c) pressuring, (d) rewarding, (e) child's control, and (f) modeling. Maternal feeding behavior has been identified as a potential modifiable characteristic in several studies. Although the definitions were variable, the concept of responsiveness has continued to be a main theme identified as important in influencing the identified outcomes.

In summary, maternal responsiveness is the observable product of the decision-making processes proposed by Ainsworth (1969b) as maternal sensitivity. Maternal responsiveness has been used to measure the quality of the maternal-infant interaction for nearly 50 years. Maternal responses have been defined as positional, verbal, visual, or tactile responses, contingent with infant feeding cues (Aboud et al., 2009; Ainsworth, 1969b; Donovan & Leavitt, 1978). Infant feeding practices are multidimensional interactions between mother and infant and maternal responses were proposed, by this study, to be a central component affecting infant weight gain between birth and 6 months of age. Until recently, very few studies focused on maternal responsiveness and infant weight gain and there is remains a gap in the literature regarding maternal responsiveness and weight gain in full term infants aged birth to six months.

Infant feeding cues. Infant feeding cues are the signals or bids for maternal responses sent by the infant during a feeding interaction (Ainsworth, 1969a; Barnard et al., 1989). The term, cue, has been defined as (a) signal to speak or act: something said or done that provides the signal for somebody, especially an actor or performer, to say or do something; (b) prompt or reminder: something that prompts or reminds somebody to do something; and (c) response-producing stimulus: a stimulus or pattern of stimuli, often not consciously perceived, that results in a specific learned behavioral response (Merriam-Webster Collegiate Dictionary, 2003). Synonyms identified by the Encarta thesaurus associated with cue are (a) prompt meaning to be done at once without delay; (b) signal as an action, gesture, or sign used as a means of communication; (c) sign as something that indicates or expresses the existence of something else not immediately apparent; (d) indication described as a sign, signal, or symptom that something exists or is true; (e) reminder defined as a letter or message sent to remind somebody of something; and lastly, (f) nod as a transitive verb and intransitive verb to lower and then raise the head quickly in order to show agreement or recognition of to give a signal.

In the early 1970s, Barnard began satellite training of public health professionals to educate them on the signals or cues sent by the infant during feeding to the parent or caregiver

(Sumner & Spietz, 1994). A superbly detailed listing of child communication cues, encountered in the feeding interaction, has been outlined in the *Caregiver/Parent-Child Interaction Feeding Manual* (Sumner & Spietz, 1994, pp. 32-40). The four main categories are outlined, and examples are given in Table 1.

Table 1

Four Main Infant Communication Cues Encountered During the Feeding Interaction

Cue category	Definition	Example
Potent engagement cues	Strong signals of an infant's readiness for interaction	Babbling Feeding sounds Reaching toward caregiver Mutual gaze
Subtle engagement cues	Beginning signals of an infant's readiness for interaction	Brow raising Feeding posture Hands open fingers slightly flexed
Potent disengagement cues	Strong signals of an infant's need for a break in the interaction	Back arching Crying Fussing Pushing away
Subtle disengagement cues	Beginning signals of an infant's need for a break in the interaction	Dull looking eyes Gaze aversion Leg kicking Sobering

Note. Adapted from *NCAST Caregiver Parent-Child Interaction Feeding Manual* (p. 32-40), G. Sumner and A. Spietz, 1994, Seattle, WA: NCAST Publications

In 2001, Metro, Steward, and Garvin introduced the concept of *infant feeding responsiveness* as "the manifestation of physiological influenced visual, expressive, vocal, and motor reactive behaviours expressed by an infant in reaction to a caregiver's feeding attempts, indicating a readiness to feed" (p. 208). This proposed concept is similar in utility to the *clustering of cues* for hunger and satiation identified by Barnard (Sumner & Spietz, 1994). Clustering of infant communication cues have been defined as either (a) hunger, a mixture of subtle and/or potent engaging and disengaging cues clustering prior to and/or at the beginning of the feeding, or (b) satiation, a mixture of subtle and/or potent engaging and disengaging cues clustering prior to and/or at the end of the feeding (Sumner & Spietz, p. 40). An example of hunger clustering would be an infant who was crying, turning head to the caregiver, showing flexed arms, and mouthing. Whereas an example of satiety (fullness) would be an infant who was falling asleep, had lack of facial expression, and decreased muscle tone.

Mentro et al. (2001) further differentiated feeding responsiveness as “positive” or “negative” on a continuum, which is much like Barnard’s differentiation of the infant cues as engagement and disengagement. In contrast, Mentro et al. (2001) were interested in the infant’s reaction to the caregiver’s feeding attempts, whereas Barnard’s focus was global; an understanding of what the infant’s wants and needs were not just during the feeding interaction.

In summary, infant cues are part of the reciprocal and synchronous interchange with the mother during the feeding process. Infant feeing cues are specific behaviors by the infant that communicate needs to the mother during the feeding interaction. Descriptions of infant cues have been well defined and described in detail in the literature. Standard hunger cues are crying; quiet alert state; hand-to-mouth activity; sucking on fingers, fist, or pacifier; rooting; and inability to settle after positioning change, diaper change, or pacifier (Gross et al., 2010; Puckett, Grover, Holt, & Sankaran, 2008; Sumner& Spietz, 1994). Satiety cues are turns head away, holds hands in stop manner, falls asleep, slowing/pausing of sucking, and no interest in restarting feed after burp/break in sucking (Gross et al., 2010; Puckett et al.; Sumner & Spietz).

Maternal responses to infant feeding cues. Two systemic reviews focused on responsive feeding and childhood obesity were published in 2011. One review focused on responsive feeding and childhood obesity in high-income countries (Hurley, Cross, & Hughes, 2011). In this review a majority of the 31 articles reported significant associations between nonresponsive feeding and child overweight, however only four were focused on infants between birth and 6 months of age. Nonresponsive feeding was defined as “a lack of reciprocity between the parent and child, with the caregiver taking excessive control over the feeding situation” (Hurley et al., 2011, p. 495). Responsiveness in this instance is equated with control of the feeding interaction. Maternal responsiveness was measured using a self-report tool, the Infant Feeding Style Questionnaire, which asked the mother to recall beliefs and behaviors associated with her feeding style (Farrow & Blissett, 2006; 2008; Thompson et al., 2009). Feeding styles generally have been defined as the control or power that each participant has in the maternal-infant feeding interaction. For example if the control or power is shared between the infant and the mother, it is termed *authoritative* (Birch & Fisher, 1995; Thompson et al., 2009).

The second review identified that five of nine articles focused on the role of responsive feeding in overweight during infancy from birth to 6 months (DiSantis, Hodges, Johnson, & Fisher, 2011). In this review, responsive feeding was defined in the context of overweight as “prompt, contingent, and developmentally appropriate responses to the infant’s hunger and satiety cues” (DiSantis et al., 2011, p. 480). Termed as *discordant feeding*, a mismatch of maternal responses to her infant cues was hypothesized to interfere with an infant’s natural caloric self-regulating ability, which may lead to overeating and overweight (DiSantis et al., 2011). It was assumed that an infant will send signals of hunger and satiety to self-regulate caloric intake (Barnard et al., 1989; Birch, 1998; Birch & Fisher, 1995; DiSantis et al., 2011). In this article, maternal responsiveness was assumed to shape the infant’s ability to self-regulate. Further, it was hypothesized that impaired infant self-regulation leads to increased energy intake and accelerated infant weight gain. Specifically, this systematic review was based on the assumption that feeding an infant who is not signaling hunger or feeding an infant beyond satiation will impair the natural infant self-regulation process.

Very few studies have measured contingent responses in the maternal-infant feeding interaction by observation because of convenience and cost associated with coder training. Morgan (1986) used the NCAFS with 78 healthy, Canadian mother-infant dyads at 55 hours old, 2 weeks old, and 1, 2, 6 and 6 months old. NCAFS scores did not differ significantly in this sample of Caucasian (88%), educated (*M* = 15 years; *SD* = 3.4), women with a mean age of 27.6 years (*SD* = 3.9; Morgan, 1986, p. 259). For this study, the proposed measurement for maternal responses to infant cues relied on an observational tool: the NCAFS Maternal Contingent Response Subscale (NCAFScc). The NCAFScc tool (detailed in chapter 4) was selected because it defines contingent maternal and infant behaviors, outlined previously, that are identifiable by trained, certified observers (Sumner & Spietz, 1994). Other feeding interaction tools are focused on children with feeding disorders (Chatoor, Egan, Getson, Menvielle, & ODonnell, 1988) or premature infants (Brown, 2007; Brown & Pridham, 2007; Pridham et al., 2007), or are not well established (Spegman & Houck, 2005).

In summary, a gap in the literature exists where maternal responses to infant feeding cues are measured using observational tools in infants between the age of birth and 6 months. The few studies that exist mainly have focused on maternal self-report of responsiveness during the feeding interaction.

Maternal and infant characteristics. Maternal and infant characteristics have been identified in the literature as influencing weight gain or maternal responsiveness. The maternal characteristics that were proposed in the study framework are maternal age, depressive symptomatology, education, and feeding method. The infant characteristics were age, sex, and temperament. Each characteristic will be discussed.

Maternal age. Age is the length of time someone has existed, usually expressed in years (Merriam-Webster, 2003). The U.S Department of Health and Human Resources (HRSA) has defined child bearing age to be between 15 and 44 years. On average, 10.5% of births occur to women less than 20 years old; 25% between 20 and 24 years old; 50% between 25 and 34 years old; 12% between 35 and 39 years old; and 2.6% between 40 and 54 years old (HRSA, 2011). The percentage of births to women ages 20 to 24 is higher in African American and Hispanic women (32% and 29%, respectively), compared to non-Hispanic white women (22.8%;HRSA, 2011).

Studies using observation measures have tended to show that younger mothers relate to their infants in a less responsive manner (Schiffman, Omar, & McKelvey, 2003; Sumner & Spietz, 1994; Wojnar, 2008). Generally, teen mothers (younger than 18 years) relate to their infants in a less responsive manner (Barnard et al., 1989; Stiles, 2010). In studies of mothers over the age of 18 years, there does not appear to be any relation between age and maternal responsiveness. For example, in a study of 177 predominately white mothers, aged 18 to 41 years, the authors reported there was no relationship between age and self-reported maternal responsiveness (Drake, Humenick, Amankwaa, Younger, & Roux, 2007). Pederson et al. (1990) observed 40 mother-infant dyads when the infant was 12 months of age and reported no relationship between maternal age and maternal sensitivity (maternal age ranged between 22 and 39 years old).

Although age has been identified as a factor affecting maternal responsiveness by Barnard, the parent study recruitment age began at 18; therefore, age may not have been an influencing factor on maternal responses in this study population.

Maternal postpartum depressive symptomatology. Maternal psychosocial characteristics, such as postpartum depression (PPD), can play a role in how the mother interacts with her infant during feeding (Brown & Pridham, 2007; Dennis & McQueen, 2009). It has been estimated that 10 to 15% of women experience PPD (Beck, 1995; Tonick & Corrina, 2009).

One of the challenges facing researchers interested in the effects of depression has been the differentiation of PPD and postpartum depressive symptomatology. There has been a tendency for researchers to use screening measures, rather than the clinical standards, for depression in research studies because of time and cost. Therefore, comparisons between PPD and depressive symptomatology may be challenging because some studies identified women who have been diagnosed with PPD and while others simply used a screening tool (Campbell, Cohn, & Meyers, 1995; Cohn et al., 1990). The term, postpartum depressive symptomatology, is not a diagnosis of PPD; rather postpartum depressive symptomatology is an indication of the existence of signs and symptoms that are seen more often in postpartum women who are depressed (Campbell et al., 1995; Tronick & Corrina, 2009). Postpartum depressive symptomatology is identified using a screening tool, whereas PPD is a medical diagnosis.

Several studies have shown that responsiveness is reduced in women with PPD, as are the responses of the infant of a mother with PPD. Sixty-seven women diagnosed with depression and 63 comparison (nondepressed) women were videotaped interacting with their infants at 2, 4, and 6 months (Campbell, Cohen, & Meyers, 1995). Women in this study who had 6-month durations of depression were less positive (responses such as smiling or exaggerated facial expressions) with their infants at all data collection points. Secondly, infants in this study who had a depressed mother were also shown to be less positive (responses such as smile/laugh or play-face) in their face-to-face interactions at 6 months. In this study, maternal depression affected not only the maternal response, but the infant responses as well. This finding was found and supported in

Beck's 1995 meta-analysis of 19 studies on the effects of PPD on maternal-infant interaction. Compared with nondepressed mothers, Beck reported that PPD mothers display less affectionate contact behavior and that they were less responsive to infant cues. According to Beck, PPD has a medium to large effect on mother-infant interactions during the first year after delivery. The maternal-infant interaction is affected by PPD. These studies have indicated that a woman with PPD is less responsive during interactions with her infant and that the infant learns to be less responsive in turn.

In a research study focused on responsive feeding, 702 mothers answered a telephone survey focused on mental health and feeding practices (Hurley et al., 2008). Less responsive feeding styles–meaning the mother is in control of the interaction, not sharing or responding in the interaction with her infant–were seen in women with higher maternal depressive symptomatology scores. In a study using signal detection methodology to evaluate maternal responses to infant cries, overall, depressed mothers were found to be less likely to discriminate among differences in infant cries (Donnovan, Leavitt, & Walsh, 1998). Both studies showed a tendency of less responsive behavior to be seen in depressed mothers.

These studies have suggested that there are cumulative effects between postpartum depressive symptomatology and less responsive mother-infant interactions during the first year of life (Cohn et al., 1990; Donnovan et al.1998; Stein et al., 2009). Screening tools can be used to identify mothers at risk for PPD, and in turn, maternal-infant dyads at risk for lower responsiveness in the feeding interaction. The symptom clusters or characteristics of PPD include anxiety, concentration impairments, and depressive mood (Beck, 1995; Dennis & McQueen, 2009). For 30 years, studies of the effects of PPD on the maternal-infant interaction have shown that mothers with more depressive symptomatology have lower responsiveness to their infants (Clark, Hyde, Essex, & Klein, 1997; Cohn et al., 1990; Dennis & McQueen, 2009; Hurley, Black, Papas, & Caufield, 2008; Pridham, Schroeder, Brown, & Clark, 2001; Stein et al., 2010; Tronick & Reck, 2009). This less responsive interaction has been described as a mother who has less affectionate contact behavior, is withdrawn with flatness of affect, is less responsive to cues such as crying, or is intrusive and hostile. Based on the literature, a mother with depressive symptomatology is less responsive to her infant's cues.

Maternal education. Education is defined as acquiring knowledge at a school or similar institution (Merriam-Webster, 2003). Barnard et al. (1989) reported a linear relationship between education and overall NCAST scores; the more years of education a mother had, the higher her average score on the NCAST, which measures the overall quality of the maternal-child interaction. In a survey of 368 urban Latina WIC (Special Supplemental Nutrition Program for Women, Infant, and Children) participants, mothers with less than a high school education were found to demonstrate less responsive feeding interactions (Gross et al., 2010). In a recent study of 112 African-American mothers of preterm infants, having less than a high school education was designated as a risk factor for attachment issues because of its influence on maternal responsiveness (Candelaria, Teti, & Black, 2011). These studies suggest that maternal responsiveness increases as maternal education increases.

Maternal choice of feeding method. Feeding methods are divided into breastfeeding, bottle-feeding (either breast milk or formula), and introduction of solids (anything other than breast milk or formula). Exclusive breastfeeding for infants from birth to age 6 months is recommended by the AAP (Krebs & Jacobson, 2003), the CDC (2011), and the WHO (2011). Feeding method as an influential process on maternal responsiveness will be explored.

Breastfeeding is one method of infant feeding. Once milk production is established, approximately four days after birth, it is maintained by a feedback system controlled by infant demand or sucking (Small, 1998). It is estimated that less than 5% of women have any physiological issues to producing enough milk to support appropriate infant growth; therefore, the choice to breastfeed in the majority of women is a personal one (maternal characteristic) versus physiological lack of production (Gatti, 2008).

Studies focused on breastfeeding and maternal responsiveness have shown mixed results (Britton, Britton, & Gronwaldt, 2006; Drake et al., 2007; Tharner et al, 2012). In a prospective study, breastfeeding practices of 675 participants were gathered at 2 and 6 months followed by an assessment of maternal responsiveness at 14 months (Tharner et al, 2012). In this study, a longer duration of breastfeeding was shown to be associated with higher maternal responsiveness. This finding was also supported in an early study of 152 mothers using the NCAST-feeding scale to measure maternal sensitivity when the infant was 6 months of age; higher maternal responsiveness scores were seen in women with longer duration of breastfeeding (Britton et al., 2006). Conversely, in a sample of 177 mother-infant dyads with infants between the age of 2 and 4 months, breastfeeding was not found to explain a measure of maternal self-report on responsiveness (Drake et al., 2007). There is a gap in the literature regarding a comparison of breast and bottle-feeding. These studies have suggested that a longer duration of breastfeeding increases maternal responsiveness.

Studies have also been conducted to investigate the relationship between breastfeeding (feeding method) and obesity in childhood (Arnez, Ruckerl, Koletzko, & Kries, 2004; Michels et al., 2007; Owen et al., 2005). In a 2004 systemic review, breastfeeding was found to have a small, but consistent, protective effect against childhood obesity (Arnez et al., 2004). A second quantitative review reported a similar advantage associated with breastfeeding and BMI (Owen et al., 2005). In 35,526 participants of the Nurses' Health Study II, obtained by a retrospective history of breastfeeding, being breast-fed was not found to be related to being overweight in adulthood (Michels et al., 2007). In a study using magnetic resonance imaging (MRI), the MRIs of breastfeeding mothers were shown to be more active than formula-feeding mothers (Kim et al., 2011). These studies focused on breastfeeding and infant weight gain have suggested that breastfeeding may be a protective factor against the development of childhood obesity. It was proposed by the study framework for this dissertation, that maternal responses to infant feeding cues may be influenced by the choice of feeding method.

Another choice of nutrition delivery is the use of a bottle. The content and nutritional value of a bottle varies depending on the content: formula, expressed breast milk, additives such as cereal, fruit juice, or whole cow's milk.

One criticism of bottle-feeding seen in the literature is related to *task-orientation*. "The degree to which mothers focused on the task of feeding, rather than their infants' social–emotional cues," was measured as task orientation in a study of 130 mother-infant dyads (Tluczek, Clark, McKechnie, Orland, & Brown, 2010, p. 4). Mothers showing higher task-orientation were less responsive to their infants' cues (Tluczek et al., 2010). It has been theorized that mothers use cues from the bottle (amount of fluid remaining in the bottle) and not cues from the infant to continue or end the feeding (Dewey, 2001; Worobey, Lopez, & Hoffman, 2009). In a second study comparing 1,250 infants, 27% of exclusively breastfed infants, 54% of infants fed by both breast and bottle, and 64% of infants fed by only bottle, emptied their bottle or cup in late infancy (12 months of age; Li Fein, & Grummer-Strawn, 2008). In addition, there is a link between bottle-feeding and childhood obesity. Bottle-feeding more than 33% of the time at 6 months was associated with later bottle emptying and excess weight gain at 12 months (Li, Fein,

& Grummer-Strawn, 2010). Thus, breastfeeding mothers tend to be more responsive to their infants' cues. This may be because breastfeeding mothers do not have a visual volume cue competing against their infants' feeding cues and the mother responds to the infant cues, not the bottle cues.

A third, and final, feeding method to be considered is solid food introduction. The AAP has recommended that solid foods, anything other than breast milk or formula, be introduced to the infant between 4 and 6 months (Krebs & Jacobson, 2003). Solid foods can vary from cereal mixed with formula or breast milk to coffee, mashed potatoes, or donuts. The parent study exclusion criterion clearly indicated the infant not be fed solids prior to baseline data collection. However, study participants were permitted, during the course of the study, to employ this feeding method. Introduction of solids prior to the AAP recommendation places the infant at risk for allergies, asthma, diabetes, and excessive weight gain (Krebs & Jacobson, 2003); this was an exclusion criterion for participation in the parent study (Horodysnki et al., 2007). In a recent systemic review of 24 studies, however, no clear association between the age of introduction of solids and obesity was found (Moorecroft, Marshall, & McCormick, 2010). The introduction of solids prior to baseline data collection was a participant-exclusion criterion in the parent study. However, it is important to recognize it as a potential feeding method. Limited studies were found linking maternal responsiveness and the solid feeding method. Studies generally focused on the delay of solid introduction, because it is a known risk factor for allergies, obesity, and diabetes (Horodynski et al, 2007; Lindsay, Machado, Sussner, Hardwick, & Peterson, 2008). As mentioned earlier, there is a gap in the literature comparing feeding methods and maternal responsiveness.

In summary, infant feeding method is a maternal choice. The literature has suggested that there is a slightly higher tendency for breastfeeding mothers to be more responsive than bottle-feeding mothers. It is not clear from the literature whether this tendency is influenced by other maternal characteristics, such as the process of using the bottle. For example, Dennis and McQueen (2009) conducted a systemic review of 49 research articles focused on PPD and feeding methods. Increased breastfeeding duration, increased breastfeeding difficulty, and decreased levels of breastfeeding were seen in women with depressive symptomatology (Dennis & McQueen, 2009). Second, as level of education increased, breastfeeding rates were found to increase (CDC, 2010). Regardless of the reason a mother chooses a feeding method, it can affect the mother's responses during the feeding interaction (Brown & Pridham, 2007; Goodell et al., 2009; Li, Fein, & Grummer-Strawn, 2008). It is important, therefore, to consider feeding method a maternal characteristic, which has the potential to influence the feeding interaction and maternal responsiveness to infant feeding cues.

Infant age. In early infancy, age is usually expressed in days, weeks, or months. Growth and development occurs rapidly during the first year of life (Ball et al., 2012). The ability of an infant to communicate or send cues more effectively increases as the infant matures, making the age of the infant a potential factor influencing maternal responsiveness (Lamb & Easterbrooks, 1981; Mentro et al., 2002).

Based on 914 infants aged 1 to 36 months, Barnard et al. (1989) reported that as infant age increased so did overall scores on the NCAST feeding scale. Barnard et al. noted that this was because some NCAST-F items required behaviors younger infants had not yet developed. For example, question 61 on the NCAFS asks if the "child smiles or laughs during feeding" (Sumner & Spietz, 1994, p. 142); according to Ball et al. (2012), on average, an infant will start smiling around 6 weeks of age. Gestures or the ability to pronounce legible words begin between

8 and 14 months of age; younger infants would not have developed this skill (Iverson, 2010). Thus, prior to 8 months of age, infant communication are the cues described earlier (e.g., sounds such as crying, squealing, fussing, whining, and feeding), and gestures such as facial expressions, decreased muscle tone, and gaze aversion (Barnard et al., 1989; Mentro et al., 2002; Sumner & Spietz, 1994).

The effect of infant communication on maternal responsiveness has been well-illustrated in the premature infant population (Brown, 2007; Brown & Pridham, 2007; Olafsen et al., 2012; Pridham et al., 2007). The preterm infant provides less cue clarity and consistency, and parents are taught to increase their responsiveness to compensate (Olafsen et al., 2012). Vallotton (2009) also found that smiling and crying affect maternal responsiveness. In this study, the effect that gestures and signs of 10 infants, aged 4 to 19 months, had on 18 student caregivers were observed and it was found that “infant sign frequency and variety on caregiver responsiveness change with children’s age” (Vallotton, 2009, p. 13). These studies have indicated that infant age and development may be a factor influencing maternal responsiveness.

Infant sex. Sex is a term used to differentiate male or female. Early studies found that male infants were less responsive to auditory and social stimuli than female infants (Oscofsky & O’Connell, 1977). Male infants also smile less and display more irritability, crying, facial grimacing, and changes in emotional state than female infants (Feldman, Brody, & Miller, 1980; Malatesta & Haviland, 1982; Oscofsky & O’Connel, 1977). Furthermore, in a study of 69 mothers faced with a simulation, maternal sensory sensitivity for positive expression was higher when faced with a female infant (Donovan, Taylor, & Leavitt, 2006). Conversely, the matching of maternal responses was found to differ between male and female infants. Malatesta and Haviland (1982) reported that mothers were found to match (e.g., smile for smile) more male infant expressions (vs. female), and follow more female (vs. male) expressions with dissimilar responses (p. 1001). Malatesta and Haviland attributed this difference to the fact that male infants tended to react more negatively, were more irritable, and were less consolable, therefore, mothers needed to work harder to interact with the male infant. Although Barnard et al. (1989) did not indicate infant sex as a factor influencing NCAST-F/PCI-F caregiver scores, gender differences in infant expression and maternal responsiveness were found in the literature, both potentially influential to the maternal-infant interaction.

Infant temperament. This concept was greatly researched and studied in the 1980s (Campbell, 1979; Carey, 1985; Crokenberg, 1986; Goldsmith et al., 1987; Rothbart, 1981). It has been generally agreed upon that temperament is made up of several dimensions of behavior and that these behaviors can be identified in infancy (Else-Quest, Goldsmith, & Van Hulle, 2006). Temperament behavioral dimensions commonly have included activity, emotionality or emotional intensity, and approach or withdrawal (Else-Quest et al., 2006). Major theoretical differences in defining temperament have been based on the weight a particular behavior is given in the definition (Else-Quest et al., 2006; Goldsmith et al., 1987). Secondly, antecedent factors, such as biological substrates and environmental or contextual factors have been theorized to influence temperament (Crokenberg, 1982; Else-Quest et al., 2006).

The theory of temperament has been based on behavioral styles. Inductive content analysis of parent interviews of 22 children produced nine temperament dimensions: (a) activity, that is, motor activity, (b) rythmicity, that is, predictability or regularity of behavior, (c) approach or withdrawal, that is, response to novelty, (d) adaptability, that is, response to alterations in environment, (e) threshold of responsiveness, that is, intensity of stimulation necessary to evoke reaction, (f) intensity of reaction, that is, the energy level of a response, (g) quality of mood, that is, amount of pleasant or positive mood, (h) distractibility, that is, effectiveness of environmental stimulation in altering the child's direction of behavior, and (9) attention span and persistence, that is , length of time and maintenance of activity pursued by the child (Else-Quest et al., 2006; Thomas, Chess, & Birch 1968).

These nine dimensions of temperament were found to be reliably identifiable in infants as early as 2 to 3 months of age in a wide diversity of population samples (Thomas et al, 1968). Further, three attributes were found to have behaviors that clustered together in a sample of 353 children. Approximately 40% of the sample was described as *easy*, meaning infants easily established a regular sleeping and feeding schedule, were cheerful, and easily adapted to new routines, food, and people. A second group comprising 15% of the study population was described as *slow to warm up*, meaning infants had low activity levels, withdrew from new stimuli, adapted slowly, were negative in mood but were generally quiet in emotional expression. Lastly, about 10% of infants were described as *difficult*, meaning they had irregular sleeping and eating patterns, cried more, adapted to new routines slowly and emotional expressions were loud. The remaining 35% were described as having a mixture of behavior attributes, showing no particular cluster pattern.

Variations in temperament have been described much the same way by other authors (Rothbart, 1981), with the addition of individual predispositions or particular reaction (reactivity) to such things as distress or smiling and laughter. This addition has provided a psychobiological approach and added the "why" of behavior or the motivation of the behavior. Rothbart theorized temperament as a context-specific expression of a disposition rather than characteristics that are evident in all behavior. Rothbart's definition of temperament was based on individual differences in reactivity and self-regulation.

There have been three models in the literature associating infant temperament and maternal responsiveness (Crockenberg, 1986). First, different infant temperaments will elicit distinct patterns of care giving. In this case, a mother will be less responsive to her baby if she perceived the infant as “difficult.” A second theory, Goodness-of-Fit, depends on characteristics of the caregiver or care giving context, associations between temperament and maternal responsiveness (or care giving), which will be negative or positive. Lastly, it is possible that temperament and care giving practices are essentially independent, and thus there would be no association between temperament and maternal responsiveness.

The difficult temperament became a particular research interest because this behavior style posed caregiver challenges and therefore was theorized to place the child at-risk for behavioral problems (Else-Quest et al., 2006). The at risk designation given to infants with difficult temperament prompted research and expansion of this behavioral style. Early researchers conceptualized the difficult temperament as irregular biological functioning, poor adaptability, high emotionality, high fearlessness, and high frequency of fussing and crying. Rothbart (1982) challenged the use of the word “difficult” as a descriptor for temperament, reasoning this term had negative connotations. Literature has proposed that infants with difficult or distressed behavior or low activity gain more weight in infancy (Carey, 1985; Niegel et al., 2007; Paul et al., 2009; Slining, Adair, Goldman, Borja, & Bentley, 2009). A reasonable explanation is that difficult infants are fed more often to soothe and quiet them, while active infants use more energy (Niegel et al., 2007; Paul et al., 2009).

Infant temperament or differences in reactivity (Derryberry & Rothbart, 1988), can include various levels of fear, positive and negative affect, sadness, distress to limitations (fussiness and crying), and activity perceived by the mother (Slining et al., 2010). From the literature focused on attachment theory, it is has been agreed upon that infant temperament has an influence on maternal responsiveness. Further, literature has suggested that an infant with a difficult temperament may gain more weight in infancy (Carey, 1985; Niegel et al., 2007; Paul et al., 2009; Slining et al., 2010). The Barnard PCI model has identified infant responsiveness to the parent as an infant characteristic (Sumner & Spietz, 1994, p. 9). By definition, temperament includes reactivity and should be considered as influential in the maternal-infant feeding interaction.

Conclusion and Significance

It has been recognized that there are some gaps in the literature related to early infant weight gain, such as a consistent definition of RWG, identification of risk-factors for RWG, use of observational tools to measure maternal responsiveness, and a comparison of maternal responsiveness between breast, bottle and solid feeding methods. This study is a beginning effort to fill those gaps and advance the science of maternal-infant research in the area related to early infant weight gain.

The primary purpose of the study was to determine to what extent maternal responses to infant feeding cues are associated with weight gain patterns in infants between birth and 6 months of age. This study has begun to examine infant feeding practices that may influence RWG with a guiding model to explain characteristics of the two participants in the didactic infant feeding interaction: the person feeding (in this case the mother) and the person being fed (the infant). Secondly, this study examined these characteristics and the weight gain patterns of infants in a population at high-risk (low-income) for development of childhood obesity. Special attention was given to RWG, when these infants were between birth and 6 months old, utilizing the WHO Infant Growth Standard as a comparison. The study model hypothesized links between infant weight gain and the maternal-infant feeding interaction (contingent maternal responsiveness), along with maternal characteristics (age, education, depressive symptomatology, and feeding method) and infant characteristics (age, sex, and temperament).

The literature consistently has identified maternal responsiveness as an important factor in the reciprocal mother-infant feeding interaction (Ainsworth, 1969; Amankwaa & Pickler, 2002; Hodges et al., 2007; Lamb & Easterbrooks, 1981; Lutz et al., 2009). In the literature review, studies have indicated that maternal responsiveness is lower in mothers who are younger, less educated, showing postpartum depressive symptomatology, and bottle-feeding. Although maternal age is a possible factor influencing maternal responsiveness, the literature review indicated lower maternal responsiveness is only significant if the mother is 18-years-old or younger. In respect to feeding method, there have been some inconsistent findings associated with the claim that breastfeeding mothers have greater maternal responsiveness, so the findings of this study will add to the state of the science regarding breastfeeding and maternal responsiveness.

Infant age, sex, and temperament were all shown to be influential factors on the mother in the maternal-infant feeding interaction; specifically, maternal responsiveness. As the infant ages, the development of more sophisticated communication skills improves; therefore, the maternal-infant interaction may also be influenced by infant age. Mothers react differently to male and female babies; this may be linked to temperament, infant sex, or both. Infant temperament has been explored in the research literature for more than 40 years (Thomas et al., 1968). Recent literature has focused on a link between infant temperament and infant weight gain in older infants, showing that difficult infants tend to gain more weight, but few studies have focused on infants from birth to 6 months.

This chapter also discussed infant growth and standardized infant growth charts used for comparison. It is important to recognize that the WHO Infant Growth Standard has assumed that ideal infant growth is achieved in a population when mothers are nonsmokers and the recommended practice of exclusive breastfeeding is followed. Definitions of obesity, infant overweight, and RWG were inconsistant in this literature review, and it has been recommended that a concept analysis be completed for RWG. The concepts identified in the study framework were reviewed, and it has been hypothesized that these variables will be significant in predicting RWG for infants from birth to 6 months of age.

The review of the literature provided an understanding of several gaps in knowledge related to key demographics, as well as maternal and infant characteristics associated with infant weight gain. These gaps included a lack of studies that identify risk factors for RWG in infants aged birth to 6 months, comparison studies of maternal responsiveness and feeding method, and a clear definition of RWG. In response to the critical lack of research in risk-factors associated with RWG, this study proposed characteristics thought to influence the maternal-infant feeding interaction or feeding practices seen in infants aged birth to 6 months of age. The significance of the study was to expand the knowledge of risk-factors associated with RWG for the design of future nursing interventions. Chapter 4 will be a discussion of the design of the study and analysis of the data.

Chapter 4

Methods

The purpose of chapter 4 is to discuss the methodology of the study. The study design, sample, and data collection procedures for the parent study will be discussed in the following sections. Data analysis and instruments proposed to answer the study aims will be introduced. Institutional Review Board approval was granted May 2011 from Michigan State University.

Research Design

This study relied on a secondary analysis of data from *Healthy Babies through Infant Centered Feeding (USDA 2009-55215-05220*), an ongoing study which is a longitudinal, randomized-cohort intervention study designed to support maternal responsiveness, feeding style, and feeding practices as low-income mothers transition to feeding their infants solid foods. The Healthy Babies study is a collaborative effort with Michigan State University, Michigan State University Extension in three Michigan counties, and two counties in Colorado through extension offices of Colorado State University. The USDA, National Institute of Food and Agriculture, and Food Research Initiative grant is funded from March 2009 to February 2013. Dr. Mildred Horodynski serves as the principle investigator.

The current study was a secondary analysis using Time 1 (T1) data collected and entered from the Healthy Babies study between January 2010 and May 2011. Although additional Healthy Babies data collections have occurred (e.g., Time 2 and Time 3), this study is confined to potential variables associated with infant weight gain before age 6 months and prior to receiving the intervention: Healthy Babies lessons or the control group lessons.

Purpose of the study. The primary purpose of this study was to determine to what extent maternal responses to infant feeding cues are associated with weight gain patterns in infants between birth and 6 months of age.

Problem statement. Two weight-related risk-factors in infancy that have been identified in the development of childhood obesity are (a) weight greater than or equal to the 85th percentile when compare to the standard growth curve, or (b) RWG. Identification of risk-factors for development of RWG in infants aged birth to 6 months has been lacking in the literature, although infant feeding practices have been suggested as a starting point in the investigation. In chapter 2, a study framework was proposed that identified feeding practices thought to influence weight gain and RWG in early infancy.

Based on the literature presented in chapter 3, the investigator hypothesized that maternal responses to infant feeding cues will be observed less often in infants with RWG. Specific aims of this study were to (a) determine to what extent maternal responses to infant feeding cues are associated with weight gain in infants between birth and 6 months, (b) determine to what extent maternal characteristics (age, depressive symptomatology, education, and feeding method) are associated with maternal responses to infant cues, and (c) determine to what extent infant characteristics (age, sex, and temperament) are associated with maternal responses to infant cues.

Sample

Recruitment for the Healthy Babies parent study began January 2010 and continued through December 2011. A convenience sample of mothers, 18 years of age or older at the time of their infants' birth, were recruited from three mid-Michigan counties affiliated with Michigan State University Extension offices and two counties in Colorado through extension offices of Colorado State University. Eligible participants had to qualify for WIC or Supplemental Nutrition Assistance Program. Both of these food assistance programs are federally funded and require participants to be at or below the 185% of poverty. Infant criteria were that birth weight was at or above 2,500 g and that the infant was not fed solids (anything other than breast milk or formula) at or prior to data collection T1. Eligibility was also limited to healthy infants and mothers, neither of whom had been diagnosed with an eating disorder or a chronic physical or mental disease.

The current study sample included all Healthy Babies mother-infant dyads with complete data entry as of May 26, 2011, when infants were between 10 and 152 days old or approximately 1 week to 5 months. The study sample available for analysis contained 136 mother-infant dyads.

Although the parent study originally stipulated that only infants weighing 2,500 g or more were to be included, some women were recruited during pregnancy, before the infant weight was known. As a result, 11 (8%) infants had a birth weight less than 2,500 g. Seven of the 11 infants were shown to have WHO Anthro WAPs less than 3%. Because the weight gain curve for infants with WAPs lower than 3% may not follow the standard WHO growth curve, RWG cannot be calculated with confidence for these infants. They were thus excluded from the analysis, leaving an effective sample size of 129 mother-infant dyads.

Healthy Babies (Parent Study) Data Collection

Data collectors for the parent study were recruited and initially trained during a two-day intensive workshop in January 2010. During this workshop, data collectors were taught how to obtain informed written consent, perform anthropometric measurements on both infants and mothers (height, recumbent length, and weight), use video equipment for the feeding observation, and ask the questions in the questionnaires.

Ideally, women who had expressed interest in participating in the Healthy Babies program were contacted by the data collectors who scheduled a visiting time when the infant normally ate. A timeframe of two hours was scheduled for data collection. Once a data collector arrived at the mother's home, informed written consent and anthropometric measurements were taken. The mother-infant dyad feeding interaction followed and was recorded on video. The remainder of the data collection time included the data collector reading each question from the survey packet and recording the mother's responses to those items.

Each year of the parent study, data collectors participated in a booster training session. The booster training included a review of anthropometric measurement techniques and validation of competency by having data collectors show correct technique using return demonstration on a known standard mother-infant dyad. Responsible conduct of research was reviewed. Recording techniques to enhance the quality of the video (e.g., lighting) were discussed, demonstrated, reviewed and critiqued.

Consent. Written, informed consent was obtained from all of the participants enrolled in the Healthy Babies parent study.

Anthropometric measurement. Anthropometric measurement of infant weight and recumbent length were taken by a trained data collector at Times 1, 2, and 3 according to a written Healthy Babies protocol. "The infant is weighed in a clean diaper on an electronic scale, positioned in the center of the scale tray and weighed to the nearest half ounce" (Horodynski et al., 2011, p. 4). Maternal recall of infant birth weight and length were asked at T1 data collection. Measures for maternal weight and height were only collected at Time 2 and Time 3 data collection.

Video recording of the mother-infant feeding interaction. The mother-infant feeding interaction was video recorded with limited interference per protocol. The data collector was instructed not to stage the scene by requesting the participant to move for a better camera angle. The data collectors were discouraged from asking or answering questions during the recording or interfering with natural conversation or tasks performed by the participant. For example, if the television was on during the feeding, the data collector did not request it to be turned down or off.

Video scoring protocol of maternal-infant feeding interaction. Maternal-infant feeding interactions were scored using the NCAFS or NCAST-F, interchangeably called the PCI-F (Sumner & Spietz, 1994). The NCAFS scoring was completed by individuals that have shown reliability in observing the behaviors contained in the scales (Sumner & Spietz, 1994). Training for NCAFS coders is conducted by a certified NCAST instructor and consists of reading the NCAFS Feeding Manual, becoming familiar with the maternal and infant subscale items, viewing each subscale video, and coding practice videos produced by NCAST. The training process occurs over a 6-week period; recertification is required on a yearly basis. The certification process is prescriptive. Following reading the manual and practice videos, testing occurs in which five selected caregiver-infant interaction videos on DVD from NCAST productions are reviewed and coded (Sumner & Spietz, 1994). Scoring is completed on a scoring form from the NCAST Feeding Manual, which is sent to NCAST productions for scoring, and determination of reliability is made. Achievement of reliability in the use of the NCAFS at the level required for research purposes is 90% agreement with the standard score set by NCAST productions and 85% agreement for practice purposes. Only notification of the level, either research or practice reliability, is communicated back to the instructor and the prospective coder. No review or comparison of item-scoring is done in order to maintain the integrity of the testing videos.

Video scoring was completed following the Healthy Babies protocol (Appendix B). Each Healthy Babies maternal-infant feeding interaction was scored individually by two certified

NCAFS coders. On average, coders disagreed on 10 of 76 items for an average inner-rater reliability of 87% (*N* = 30, *M* = 10.36, *SD* = 3.59, *min* = 6, *max* = 21). A final NCAFS score was agreed upon, by consensus, between the two coders through discussion and review of each Healthy Babies mother-infant feeding interaction video. Each coder maintained anecdotal notes and video times on his or her scoring sheet to aid in this process.

Maternal self-report survey packet. Questionnaire items were read out loud from the survey packet to participants by the data collector per protocol. The data collector then recorded the maternal response to each question in the survey packet. The survey packets contained all the self-reported questionnaires used in the Health Babies study.

Intervention for the Parent Study.

The intervention in the Healthy Babies parent study began after the T1 data collection and therefore did not affect the current analysis, which used only T1 data. Women were randomly assigned to either the control or intervention group for nutritional education (Horodynski et al., 2011).

Intervention group. The Healthy Babies intervention in the ongoing parent study consists of a series of six in-home lessons developed from a pilot study, The Infant Feeding Series (Horodynski, Olson, Brophy-Herb, Shirer, & Arndt, 2008). The six lessons are delivered by a trained nutrition instructor in a one-on-one, face-to-face interaction during home visits according to the prescribed curriculum protocol; following the six lessons, three reinforcement telephone calls are made to the mothers by instructors (Horodynski et al., 2011). Each Healthy Babies lesson lasts approximately 60 min. The lessons have been designed from research-based literature to support the development of healthy feeding techniques that promote healthy infant eating habits. These six lessons are considered infant-centered and provide the mother with hands-on skills, interactive demonstrations, and discussions with the instructor. All six in-home lessons are completed by the time the infant turns 6 months of age and the follow-up telephone calls are made when the infant is 6, 8, and 10 months old.

Control group. In the ongoing parent study, each dyad in the control group receives six, 60-minute, one-on-one, face-to-face lessons in the mother's home, according to a prescribed Expanded Food and Nutrition Education Program curriculum (Eating Smart, Being Active), a standard nutrition education curriculum offered in each state through county Cooperative Extension Service program in Colorado and implemented in the control group in Michigan (Horodynski et al., 2011). The main focus of the curriculum is nutrition and the major food groups. To avoid contamination, different instructors in each county were taught either the Healthy Babies or the Easting Smart, Being Active curriculum, and were trained separately on those curricula.

Instruments Used for Current Study

Demographic information. The demographic questionnaire from the Healthy Babies study consisted of 34 questions. Common demographic questions such as maternal age, race, ethnicity, relationship status, employment status, income, and educational level were asked by the data collector. Lifestyle questions such as smoking status, dieting, and physical activity were also addressed. In addition, questions regarding confidence on feeding healthy foods, perceptions of infant size compared to other infants, and infant sleep patterns were available in the dataset.

NCAFS Caregiver Contingency Subscale (NCAFScc). The NCAFScc is a subscale of the NCAFS, a binary assessment tool used to measure the quality of the maternal-infant feeding interaction. The full NCAFS contains76 items and was recommended for use in infants between 3 and 13 months of age (Barnard et al., 1989; Foss, Hirose, & Barnard, 1999; Sumner & Spietz, 1994). The NCAST-F/PCI-F tool scores observable maternal and infant behaviors using six subscales. The NCAFS coder scores the mother's behavior on four subscales: (a) sensitivity to the infant's cues (16 items), (b) alleviating the infant's distress (11 items), (c) fostering cognitive development (9 items), and (d) fostering social-emotional development (14 items). Infant behavior is scored on two subscales: (a) clarity of cues (15 items) and (b) responsiveness to the actions of the caregiver (11 items). Occurrence of behavior was scored as "yes" or "no". The four maternal subscales were summed into a total maternal score, and the two infant subscales were summed for a total infant score. All subscales (76 items) were summed for a maternal-infant combined score.

The NCAFS contains a total of 18 maternal-child contingency items. These contingency items were found within each of the six subscales previously mentioned, making two additional subscales: (a) the caregiver contingency subscale and (b) the infant contingency subscale. Items in these two contingency scales were "if, then" questions. For example, "When the infant is showing subtle disengagement cues, does the mother allow pauses in feeding?" (see Appendix A for a complete listing of subscale questions). Contingency items were present in each of the four maternal subscales. These contingency items were combined to form a maternal contingency scale. Combined, the mother was scored on 15 contingency items. Internal consistency reliability was reported as having an alpha of .73 for the maternal contingency scale (Sumner & Spietz, 1994, p. 109).

Type of feeding. The NCAFS includes a checkbox for type of feeding observed. The options were breast, bottle, or solid.

Infant Behavior Questionnaire (IBQ)-Revised-Very Short Form. The original IBQ was introduced by Rothbart in 1981 as a measure of caretaker-reported infant temperament. The

IBQ was revised (IBQ-R) and expanded to measure 14 temperament dimensions in 1998. Further refinement to shorten the IBQ occurred in 2008, (e.g., IBQ-R short, 90 questions, and IBQ-R very short form, 37 questions).

The initial premise for Rothbart (1981) to develop a caretaker-reported infant temperament instrument (the IBQ) was to study both developmental continuity and change in patterns of behavior over time. Rothbart acknowledges that the IBQ does not measure temperament independently of the infant environment. The scale measures caregiver (maternal) perceived infant temperament.

In 1981, Rothbart sought to change what was perceived as conceptual overlap in the operational definitions of temperament dimensions. The IBQ items were developed to assess one of 11 different dimensions of temperament. Seven of those are activity level, fear, distress expressed to limitations, overall negative emotionality, smiling and laughter, duration of orienting, and distractibility. The remaining four address infant response assessed through four different sensory channels: (a) threshold, (b) intensity of response, (c) adaptability (soothability) of response, and (d) rhythmicity. Rothbart sought to design questions that were not global judgments. For example, parents were given specific behaviors: “During the past week, when being undressed, how often did your baby wave his/her arms or kick?” Item responses for the IBQ scale are forced response: 1 (*never*), 2 (*very rarely [once or twice]*), 3 (*less than half the time*), 4 = (*about half the time*), 5 (*more than half the time*), 6 (*almost always*), 7 (*always*), and NA (*does not apply*). Rothbart also designed this instrument to measure development. Therefore, some tasks or situations described may not apply to a younger infant. For example, “during a peekaboo game, how often did the baby laugh,” developmentally, a 1-month-old may not be laughing yet. Subsequently, the scoring process explains that items answered as “does not apply” should not be used to calculate the mean scale scores; instead, the score is only calculated using the items that were answered by the caregiver.

The very short form of the IBQ-R was used in the Healthy Babies parent study. The IBQ-R very short form contains two to four items from each of the original 14 temperament dimensions in the IBQ (Helbig, Putnam, Gartstein, & Rothbart, 2009). The IBQ-R very short form no longer distinguishes all 14 dimensions; instead the IBQ-R very short form measures only three higher-order temperament behaviors: (a) surgency (approach, vocal reactivity, high intensity pleasure, smiling and laughter, activity level, and perceptual sensitivity), (b) negative affect (sadness, distress to limitations, fear, and negatively, falling reactivity), and (c) effortful control (low intensity pleasure, cuddliness/expression of enjoyment, duration of orienting, and soothability). Surgency is described as similar to the adult personality trait of extroversion (Putnum, Gartstein, & Rothbart, 2006). Infants with higher surgency scores tend to be more positive, active, or reactive to/with their environment. Surgency is sometimes referred to as positive emotionality (Gartstein & Rothbart, 2003). Infants with a negative affect are described as harder to be around because their personality tends to be dominated by fear, anger, and sadness (Putnum et al., 2006) . Effortful control is the ability to control and regulate a response (Helbig, Putnam, Gartstein, & Rothbart, 2009). Temperament dimension definitions within each higher-order temperament scale are detailed in Tables 2-4.

Table 2

IBQ-R Very Short Form Higher-Order Temperament Subscale: Surgency (IBQ-S)

Temperament dimension measured in the original IBQ	Definition
Activity level	Baby's gross motor activity, including movement of arms and legs, squirming, and locomotor activity.
Smiling and laughter	Smiling or laughter from the child in general caretaking and play situations.
High intensity pleasure	Amount of pleasure or enjoyment related to high stimulus-intensity, rate, complexity, novelty, and incongruity.
Perceptual sensitivity	Amount of detection of slight, low-intensity stimuli from the external environment.
Approach	Rapid approach, excitement, and positive anticipation of pleasurable activities.
Vocal reactivity	Amount of vocalization exhibited by the baby in daily activities.

Note. IBQ = Infant Behavior Questionnaire; IBQ-R = revised Infant Behavior Questionnaire. Adapted from *Development and assessment of short and very short forms of the infant behavior questionnaire-revised*, A.L. Helbig, S.P. Putnam, M.A.Gartstein, and M.K. Rothbart, 2009, April. Presentation at the biannual convention of the Society for Research in Child Development, Denver, CO.

Table 3

IBQ-R Very Short Form Higher-Order Temperament Subscale: Negative Affect (IBQ-NA)

Temperament dimension measured in the original IBQ	Definition
Distress to limitations	Baby's fussing, crying, or showing distress while (a) in a confining place or position, (b) involved in caretaking activities, or (c) unable to perform a desired action.
Fear	The baby's startle or distress to sudden changes in stimulation, novel physical objects, or social stimuli; inhibited approach to novelty.
Falling reactivity	Rate of recovery from peak distress, excitement, or general arousal; ease of falling asleep.
Sadness	General low mood; lowered mood and activity specifically related to personal suffering, physical state, object loss, or inability to perform a desired action.

Note. IBQ = Infant Behavior Questionnaire; IBQ-R = revised Infant Behavior Questionnaire. Adapted from *Development and assessment of short and very short forms of the infant behavior questionnaire-revised,* A.L. Helbig, S.P. Putnam, M.A.Gartstein, and M.K. Rothbart, 2009, April. Presentation at the biannual convention of the Society for Research in Child Development, Denver, CO.

Table 4

IBQ-R Very Short Form Higher-Order Temperament Subscale: Effortful Control (IBQ-EC)

Temperament dimension measured in the original IBQ	Definition
Low intensity pleasure	Amount of pleasure or enjoyment related to low stimulus intensity, rate, complexity, novelty, and incongruity.
Soothability	Baby's reduction of fussing, crying, or distress when soothing techniques are used by the caretaker.
Cuddliness	The baby's expression of enjoyment and molding of the body to being held by a caregiver.

Note. IBQ = Infant Behavior Questionnaire; IBQ-R = revised Infant Behavior Questionnaire. Adapted from *Development and assessment of short and very short forms of the infant behavior questionnaire-revised,* A.L. Helbig, S.P. Putnam, M.A.Gartstein, and M.K. Rothbart, 2009, April. Presentation at the biannual convention of the Society for Research in Child Development, Denver, CO.

The internal consistencies for the IBQ's temperament dimensions have been reported to range from 0.72 to 0.85 (Rothbart, 1981). However, the IBQ-R very short form only measured the three broader temperament factors. The internal consistency of these three factor scales were reported in a 2009 presentation at the biannual convention of the Society for Research in Child Development (Helbig et al., 2009), based on six samples (ranging in size from N = 72 to N = 154): surgency (13 items) 0.67 to 0.87, effortful control (12 items) 0.66 to 0.76, and negative affect (12 items) 0.66 to 0.79. The average correlations between the standard (90 item) IBQ and the IBQ-R very short form were 0.77.

Scoring of the IBQ-R very short form from Rothbart Labs (2011) will be described in the following paragraph. Scale scores for the IBQ-R very short form represented the mean score of all scale items within a given higher-order temperament factor. All items for a scale were averaged using the scores given by the mother for each question. If an item had a missing response or the item was answered as "not applicable" or "does not apply," this item received no numerical score and was not counted in the denominator for summing that scale score. For example, the surgency scale included 13 questions. If one question was deemed not applicable by the mother and a second question had a missing response, the total score was summed for the surgency scale and divided by 11, not 13. Only one question was reverse scored: "In the last week, while being fed in your lap, how often did the baby seem eager to get away as soon as the feeding was over?" Rothbart Labs (2011) has cautioned that there are no published norms for IBQ mean scores and that researchers should use continuous scale scores for analysis. At the time of this study, the IBQ-R-very short form was the newest IBQ tool; therefore, very few studies have been published to date using this form of the IBQ.

EPDS-3. The original Edinburgh Postnatal Depression Scale (EPDS) consisted of 10 questions. The scale was designed as a screening tool for postnatal depression with special consideration of differences between depression symptoms and complaints typically seen in early motherhood. PPD has a prominent anxiety component (O'Connor, Heron, Lover, & Alspac Study Team, 2002; Ross, Gilbert-Evans, Sellers, & Romach, 2003). Unlike most depression inventories, the EPSD screening tool has incorporated items that assess anxiety (Kabir et al., 2008). The EPDS questionnaire has been shown to correctly identify postnatal depression symptomatology 86% of the time (sensitivity; Cox, Holden, & Sagovsky, 1987). Cox et al. also reported that 78% of the time (specificity) women without postnatal depression were correctly identified as such with the EPDS, and it has shown acceptable internal consistency ($\alpha = 0.87$; 1987).

The EPDS-3, an ultra-brief screening tool, was used in the Healthy Babies parent study to identify mothers at an increased risk for PPD. The EPDS-3 consists of only three questions from the original 10 items in the EPDS (Kabir et al., 2008). The EPDS-3 uses the same 4-point Likert scales as the full EPDS and consists of three questions shown in Appendix A, Table 1. A score of 10 or greater was the referral threshold for the full EPSD and also for the EPSD-3. To compensate for the items that had been removed, EPSD-3 scores were multiplied by a constant of 10 (Kabir et al., 2008, p. 698). For example, if the sum of a mother's responses equaled 1, the EPDS-3 score was 10; this mother was positive for postpartum depressive symptomatology.

In a study of 199 racially and culturally diverse women aged 14 to19 years, three subscales of the EPSD were compared to identify an ultra-brief alternative that could be used in practice (Kabir et al., 2008). "The psychometric properties of the 3-item anxiety subscale of the EPDS were comparable to those of the full 10-item scale ($\alpha = .78$ and .89, respectively)" (Kabir, et. al., 2008, p.699). The correlation between the full EPDS of 10 or greater and the EPDS-3 of 10 or greater was reported as .639 (*p* <.01;Kabir, et. al., 2008, p.700). Comparisons of those identified as having depressive symptomatology by the EPDS-3 and confirmation by psychiatric interviews have not been reported in the literature to date and may call into question criterion validity of this scale. As indicated in the literature review, anxiety is a prominent feature of maternal depression that may be confounded by socioeconomic status. This scale was used to identify self-reported maternal postnatal depressive symptomatology as a possible influence on maternal responses. A choice was made to use a continuous scoring for the EPDS-3 in this analysis, instead of designating a category for those mothers who scored 10 or greater, in order to capture the variability seen in this sample. It was necessary to match the scoring response from those used as Healthy Babies response options to the scoring response designated as scoring responses by the original instrument (Kabir et al., 2008). These comparisons are shown in Appendix A.

Measurement of Infant Weight

Infant birth weight was obtained using maternal recall. Maternal recall has been reported to be between 68% and 90% accurate, within 100 g (Ekouevi & Morgan, 1991; Seidman, Slater, Ever-Hadani, & Gale, 1987; Wicox, Gold, Metzger, 1991). Further, recall accuracy of 90% was reported with the first-born child’s weight. It was expected that a majority of the mothers in this study would be first-time mothers. Anthropometric measures of the infant weight at T1 were obtained by trained data collectors.

WHO Anthro (version 3.1, 2010) is a computer software program for personal computers used for assessing growth and development of the world's children (WHO, 2010). WHO Anthro was developed by the WHO and used in this study as an anthropometric calculator. Birth date,

date at T1, birth weight in kilograms, and T1 infant weight in kilograms were manually entered into WHO Anthro and verified by a research assistant. WHO Anthro was used to calculate WAP and WAZ for each infant. Calculated WAZ and WAP scores for birth and T1 were then manually entered into Statistical Package for the Social Sciences (SPSS) version 17 and verified by a research assistant.

The WHO Anthro program calculates WAP based on sex-specific growth curves for children from birth to 5 years of age. Only infants who fall between two standard deviations (3rd and 97th percentile) can be tracked longitudinally on the WHO growth standard using WHO Anthro. For example a male infant born at 2,440 g was calculated to have WAP of 3% ($SD = 2$), while a female infant born at 2,440 grams was calculated to have a WAP of 2% ($SD > 2$). This was important to note because the CDC (2010) indicates very low birth weight infants (VLBW, meaning < 1,500 grams) follow a markedly different growth curve than those infants born between the 2 standard deviations. Only infants born at term falling above the 3rd percentile were included in this study.

Calculations from WHO Anthro were used to determine the outcome variable, infant weight gain, from birth to T1. Relative weight gain was calculated by dividing the total weight gain in grams by the number of days between birth and T1, giving an average weight gain per day in grams. RWG cut-points have been published in the literature as an increase of +0.67 standard deviation (or z-score). Z-scores are standardized scores representing deviations of an individual infant's weight from the mean (50th percentile) and correspond to standard deviation and percentiles on the growth curve. For example, one standard deviation corresponds with the 15th and 85th percentiles and two standard deviations correspond with the 3rd and 97th percentiles on the WHO growth standard curve. The WAZ score for T1 minus the WAZ score at birth was used to calculate RWG.

Data Analysis Plan

In total, the sample available for this study contained 136 mother-infant dyads. Tabachnick and Fidell (2007) have estimated that a good rule of thumb for ratio of cases to independent variables as $N \geq 50 + 8m$ (where m is the number of independent variables). Using these estimates, up to 10 variables can be used with a sample size of 130 to show a medium-size relationship (α =.05 and β = .20). Using an internet-supported power analysis with the highest number of predictors at 12, a sample size of 127 was needed for an alpha level of 0.05; number of predictors as 12; an anticipated medium effect size (f^2) of 0.15, and a desired statistical power level of 0.8 (Soper, 2011).

Data were analyzed using SPSS version 17 and version 20. Descriptive statistical analyses were completed to profile the study sample in terms of participant characteristics, maternal behavior in response to infant feeding cues, and infant weight gain. Continuous variables were summarized with the number of observations, mean, median, standard deviation, range, and growth curve percentiles. WAP and WAZ were calculated using WHO Anthro (WHO, 2011). Prevalence of RWG using the cut point of changes greater than +0.67 (one *SD*) in WAZ on infant growth curves between birth and data collection T1 were determined for this population.

Aim 1. The first aim was to determine to what extent maternal behavior in response to infant feeding cues are associated with infant weight gain in infants from birth to 6 months.

Using multiple regression models, infant weight gain was predicted based on the measures of maternal responses to infant feeding cues and appropriate covariates. A continuous, relative weight-gain variable was computed from birth to T1 as the dependent variable. A continuous variable measuring maternal responses to infant feeding cues was computed for the independent variable. Infant age at T1 was introduced as a time covariate. The functional shape of the association between the maternal feeding styles scales and the dependent variables were explored using linear transformations, and the best-fitting functional relation was chosen, as current literature has not specified the functional relationships model. Categorical predictor variables were accommodated in the regression models using dummy coding.

Aim 2. The second aim was to determine to what extent maternal characteristics (age, depressive symptomatology, education, and feeding method) are associated with maternal responses to infant feeding cues.

Multiple regression models were used to test for linear and/or nonlinear relationships between maternal behavior in response to infant feeding cues and the explanatory/predictor variables of maternal age, maternal depressive symptomatology, maternal education, and feeding method. Categorical predictor variables were accommodated in the regression models using dummy coding.

Aim 3. The third aim was to determine to what extent infant characteristics (age, sex, and temperament) are associated with maternal responses to infant feeding cues.

Multiple regression models were used to test for linear and/or nonlinear relationships between maternal behavior in response to infant feeding cues and the explanatory/predictor variables of infant age and infant temperament (IBQ). Categorical predictor variables were accommodated in the regression models using indicator variables (or dummy coding). Chapter 5 will present the results of the study analysis plan.

Chapter 5

Results

The primary purpose of the study was to determine to what extent maternal responses to infant feeding cues are associated with weight gain patterns in infants between birth and 6 months of age This study proposed to address the following aims:

1. Determine to what extent maternal responses to infant feeding cues are associated with weight gain in infants between birth and 6 months.

2. Determine to what extent maternal characteristics (age, depressive symptomatology, education, and feeding method) are associated with maternal responses to infant cues.

3. Determine to what extent infant characteristics (age, sex, and temperament) are associated with maternal responses to infant cues.

Results from the study will be presented in the following sections. Sample characteristics and descriptive analysis will be presented. In addition, reliability of study instruments will be presented followed by results for each study aim. Interpretation and discussion of the results and implications will be presented in chapter 6.

Descriptive Analysis

As discussed in chapter 4, the study sample included all mother-infant dyads with completed data entry between January 2010 and May 2011. The final study sample consisted of 129 mother-infant dyads. Missing data will be addressed within each variable description.

Predictor variables: Maternal and infant characteristics.

Maternal age. Maternal age was examined for frequencies and missing data. No missing data were identified. The majority of mothers were between 19 and 23 (50%) years of age. The mean maternal age was 22 years. The standard deviation was 4.31. Sample characteristics are shown in Table 6.

Maternal education. Maternal education was measured with five response categories: 1 (*did not go to high school*), 2 (*some high school*), 3 (*high school diploma/GED*), 4 (*some college*), and 5 (*college degree*). All education data were complete. A majority of the maternal participants reported either some college (*n* = 57 or 45%) or a high school diploma/General Education Development (GED; *n* = 44 or 34%), as illustrated in Table 5. One participant did not go to high school, and 24 participants (19%) reported some high school. Only three participants (2%) reported having a college degree.

Table 5

Sample Frequencies for Maternal Education

Education	Frequency
Did not go to high school	1
Some high school	24
High school diploma/GED	44
Some college	57
College degree	3
Total	129

Note: GED = General Education Development, which is a test for adults who do not have a high school diploma.

Feeding method. All data were complete in the NCAST-F/PCI-F questionnaire for observed feeding method. Two participants were observed using a feeding method other than exclusive breast or bottle-feeding on the video. One mother fed her infant solids, and the other used a mixed method of breast and bottle-feeding. A majority of mothers were observed bottle-feeding (n = 93, 72%) compared to breastfeeding (n = 36, 28%) on the mother-infant feeding videos.

Although the parent study stipulated exclusion criterion that the infant not be fed solids, this was observed in one mother-infant feeding interaction video. Maternal-reported questions pertaining to the introduction of solids were available in the Healthy Babies dataset. In the Feeding Checklist Questionnaire, the mother was asked several questions regarding solid foods. A number of participants (n = 58; 45%) reported the introduction of solids: 19 (14%) participants said their baby had something other than formula or breast milk, 38 (28%) fed their infant something to drink other than formula or breast milk, 8 (6%) participants had started feeding solids, 18 (13%) admitted to giving their baby a little taste of food, and 22 (16%) mixed cereal with formula or breast milk.

Both self-reported feeding method and observed feeding methods were taken into account; six feeding method categories were identified (see Table 6). Three dummy code variables for feeding method were used in the regression analysis: (a) any observed or self-reported bottle-feeding (yes = 1, no = 0), (b) any reported duration of breastfeeding or observed breastfeeding (yes = 1, no = 0), and (c) any self-reported or observed solid food introduction (yes = 1, no = 0).

Table 6

Sample Frequencies for Feeding Methods

Feeding method	Frequency
Exclusive bottle-feeding	23
Exclusive breastfeeding	16
Both breast and bottle	32
Both breast and solid	12
Both bottle and solid	17
All: breast, bottle and solid	29
Total	129

Note: Both breast and bottle = any reported duration of breastfeeding or observed breastfeeding AND any reported or observed bottle feeding; Both breast and solids = any self-reported or observed breastfeeding AND reported solid feeding; Both bottle and solid = any self-reported or observed bottle-feeding AND reported solid feeding; All: breast, bottle and solid = any self-reported or observed breastfeeding AND any self-reported or observed bottle-feeding AND any self-reported or observed solid food introduction.

Infant age. Infant age was calculated in days from birth to the first data collection (T1) by subtracting date of birth from date of T1 data collection. All infant age data were complete. Infant age distribution is shown in Figure 2. The mean age was 57 days, or about 2 months old, and age ranged from 10 days to 152 days (about 5 months old). There were two outliers (age 149 and 152 days).

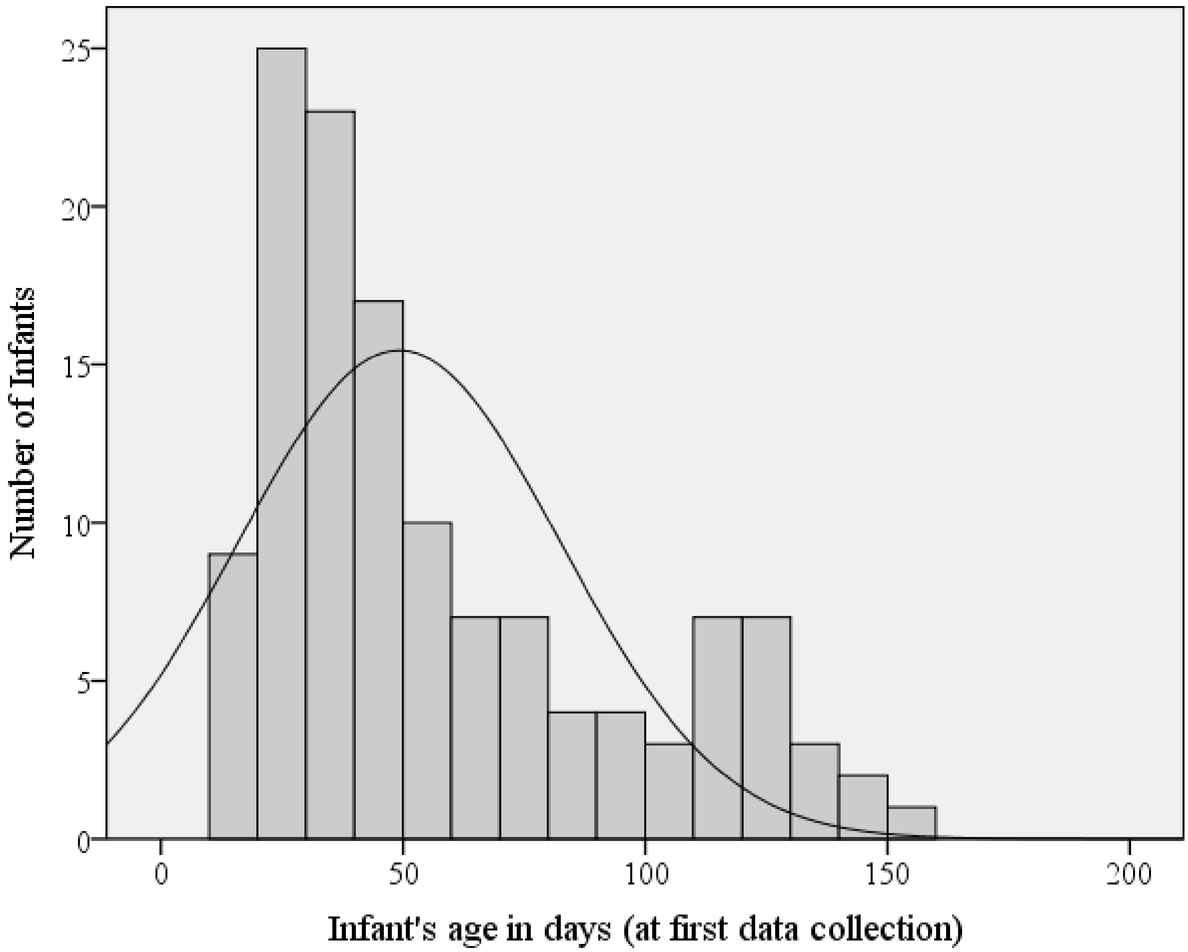

Figure 2. Infant age in days with the normal distribution curve overlay.

Infant sex. Infant sex was reported by mother on the demographic questionnaire, with no missing responses. The infant sample consisted of 66 (51%) males and 63 (49%) females.

Reliability and descriptive analysis of study instruments. Results for the following instruments will be presented in this section: NCAFScc, EPDS-3, and the three subscales of the IBQ-R very short form. A summary of all instruments is shown in Table 16.

NCAFScc. Observations of maternal behavior in response to infant feeding cues were measured with the 15-item NCAFScc of the NCAFS tool. No missing data were found in these 15 items.

Reliability analysis of the subscale items was completed (α = .703); five items had a corrected item-total less than .3 (NCAST_I.6 = .173, NCAST_I.7 = 0.90, NCAST_I.8 = .160, NCAST_I.22 = .149, and NCAST_I.49 = .220; Field, 2005). When all were removed, Cronbach's alpha improved to .755. In review of the items removed, NCAST_I.7 (caregiver comments verbally on the child's hunger cues prior to feeding) and NCAST_I.8 (caregiver comments verbally on the child's satiation cues before terminating) required that the mother comment on hunger or satiety cues; removal of those two items improved the Cronbach's alpha to .730. The remaining items were congruent with the operational definition of maternal responses to infant cues: NCAST_I.6 (caregiver smiles, verbalizes, or makes eye contact with the infant when the infant is in open-face-gaze position), NCAST_I.22 (caregiver responds to child distress by diverting attention with a toy), and NCAST_I.49 (caregiver verbally responds within five seconds of infant movement of arms, legs, hands, feet, or trunk). Because Cronbach's alpha only improved slightly (.755) with the removal of these three items, only items NCAST_I.7 and NCAST_I.8 were removed. The Cronbach's alpha for this scale was .730, which was consistent with the reported reliability of this subscale (Barnard et al, 1989; Sumer & Spietz, 1994). Corrected item-total correlations for the NCAFScc are shown in Table 7, and final sample values are shown in Table 8.

Table 7

NCAFS Caregiver Contingency Subscale: Final Corrected-Item Totals

Subscale item question	Item total correlations
6. Caregiver smiles or makes eye contact with child when child is in open-face-gaze position.	.128
12. Caregiver allows pauses in feeding when the child shows potent disengagement cues or is in the pause phase of the suck-pause sequence of sucking.	.428
13. Caregiver slows the pace of feeding or pauses when the child shows subtle disengagement cues.	.524
14. Caregiver terminates the feeding when child shows satiation cues or after other methods have proven unsuccessful.	.342
17. In response to a potent disengagement cue, the caregiver stops or starts feeding.	.380
18. In response to a potent disengagement cue, the caregiver changes the child's position.	.434
19. In response to a potent disengagement cue, the caregiver makes positive or sympathetic verbalizations.	.484
20. In response to a potent disengagement cue, the caregiver changes voice volume to softer of higher pitch.	.551
21. In response to a potent disengagement cue, the caregiver makes soothing non-verbal efforts.	.461
22. In response to a potent disengagement cue, the caregiver diverts the child's attention by playing games, introducing toy, or making faces.	.216
38. Caregiver smiles, verbalizes, or touches the child within five seconds of the child smiling or verbalizing at caregiver.	.395
48. Caregiver verbally responds to child's sound within five seconds after the child has vocalized.	.323
49 Caregiver verbally responds to child's movement within five seconds of child's movement of arms, legs, hands, head, or trunk.	.145

Note. NCAFS = Nursing-Child Assessment Feeding Scale. Items are numbered from their original order in the *NCAST Caregiver Parent-Child Interaction Feeding Manual* (pp. 141-142), G. Sumner and A. Spietz, 1994, Seattle, WA: NCAST Publications.

EPDS. One participant (0.7%) had missing responses for two EPDS-3 answers. All other EPSD-3 scores were complete. Possible scores for the EPDS-3 ranged from 0 to 30; a score of 10 or higher indicates the mother is at risk for PPD. A majority of the sample had an EPDS-3 score <u>less than or equal to</u> 10 (N = 82), meaning they scored 0 on the EPDS-3. Reliability analysis of the subscale items was completed (α= .820); corrected item-total correlations were between .638 and .747. Sample characteristics are shown in Table 11.

Table 8

Sample Values for Maternal NCAFS Caregiver Contingency 13-item Subscale (NCAFScc), Age and Edinburgh Postnatal Depression Scale (EPDS-3) Scores

Measurement	NCAFScc	Maternal age	EPDS-3
Missing data	0	0	1
Mean	7.67	22.02	2.02
Median	8.00	21.00	2.00
Std. deviation	2.58	4.31	2.23
Skewness	-.36	1.89	1.10
Minimum	2.00	17	0
Maximum	13.00	42	9
Cronbach's alpha	.73		.82

Note. NCAFS = Nursing-Child Assessment Feeding Scale (Sumner & Spietz, 1994); α = alpha
The NCAFS is scored on a binary scale of observed yes (1) and not observed (0).
EPDS-3 = 3-item Edinburgh Postnatal Depression scale (Kabir et al., 2008).

IBQ-R Very Short Form. The IBQ-R very short form measures three higher-order temperament factors: (a) surgency/extraversion, (b) negative affectivity, and (c) effortful control/regulating. A high frequency of missing data (> 15%) was found on several scale items. Documentation of frequencies, percentages of missing data, and scale questions are listed for each scale separately in Table 12. The IBQ-R very short form was developed in 2009 (Helbig et al.), thus, comparison between this study and published literature was limited. Results of internal consistency and reliability of each of the three IBQ-R subscales will be discussed.

Internal consistency reliability for IBQ-Surgency Subscale (IBQ-S). Reliability analysis of the subscale items was completed. Only 27 (21%) of participants answered all 13 items in the IBQ-S scale. Table 9 shows the “not applicable” responses (frequency and percent) for each scale item.

Three items had a corrected item-total correlation less than .3 (item sIBQ_13 = -.009, sIBQ_1 = .152, IBQ_26= .226; Field, 2005). The resulting 10-item scale had only one item with a “non-applicable” participant response rate less than 15%: IBQ_8 (7.8% non-applicable responses). Items with high non-applicable responses (sIBQ_27 = 54%; sIBQ_14 = 47%; sIBQ_2 = 41%) were evaluated for face validity and removed one at a time, evaluating the effect on the Cronbach’s alpha (Darlington & Wright, 2006; Worobey, 1986). The remaining 7-item scale now had 57 (44%) participant responses for all items. However, sIBQ-37 had a corrected item-total correlation of .279 (.351 with all scale items) and was removed. The final 6-item scale showed corrected item-total correlations greater than .462. The Cronbach’s alpha for this scale was .862, with 58 (45%) respondents answering all scale items (see Table 10), which is consistent with the reported reliability of the 13-item IBQ-S.

Table 9

Non-Applicable Response Frequencies and Percentages in the IBQ-Surgency Subscale(IBQ-S)

IBQ-S item question	"Not-applicable" response	
	Frequency	%
1. When being dressed or undressed during the last week, how often did the baby squirm and/or try to roll away?	0	0
2. When tossed around playfully how often did the baby laugh?	53	41
7. How often during the week did your baby move quickly toward new objects?	41	31
8. When put into the bath water, how often did the baby laugh?	10	8
13. When placed on his/her back, how often did the baby squirm and/or turn body?	24	19
14. During a peekaboo game, how often did the baby laugh?	61	47
15. How often does the infant look up from playing when the telephone rings?	23	18
20. When visiting a new place, how often did your baby get excited about exploring new surroundings?	38	30
21. How often during the last week did the baby smile or laugh when given a toy?	47	36
26. When hair was washed, how often did the baby vocalize?	11	9
27. How often did your baby notice the sound of an airplane passing overhead?	70	54
36. How often did your baby make talking sounds when riding in a car?	25	19
37. When placed in an infant seat or car seat, how often did the baby squirm and turn body?	4	3

Note. IBQ = Infant Behavior Questionnaire (Gartstein & Rothbart, 2003; Putnum et al., 2006).

Table 10

Final Corrected Item-Totals for the IBQ-Surgency Subscale (IBQ-S)

Subscale item question	Item total correlation
7. How often during the week did your baby move quickly toward new objects?	.679
8. When put into the bath water, how often did the baby laugh?	.655
15. How often does the infant look up from playing when the telephone rings?	.462
20. When visiting a new place, how often did your baby get excited about exploring new surroundings?	.625
21. How often during the last week did the baby smile or laugh when given a toy?	.803
36. How often did your baby make talking sounds when riding in a car?	.720

Note. IBQ = Infant Behavior Questionnaire (Gartstein & Rothbart, 2003; Putnum et al., 2006).

Internal consistency reliability for IBQ-Negative Affect Scale (IBQ-NA). Reliability analysis of the subscale items was completed. Fifty-four (42%) of participants answered all 12 items in the IBQ-NA subscale. Table 11 shows not applicable responses (frequency and percent) for each scale item.

The lowest corrected item-total correlation was .379 (nIBQ_17). The scale had six items with a non-applicable participant response rate less than 15%. Items with the highest non-applicable responses (nIBQ_33=30%; nIBQ_4=29%; nIBQ_28= 26%) were evaluated for face validity and removed one at a time, evaluating the effect on the Cronbach's alpha (Darlington & Wright, 2006; Worobey, 1986). These three items were worded such that the mother evaluated her infant response to an unfamiliar adult. More than half of the responses to these three items were not applicable or never, reducing the variability of those items (Field, 2005). The final 6-item scale showed corrected item-total correlations greater than .406. 462. The Cronbach's alpha for this scale was .834, with 64 (50%) respondents answering all scale items (see Table 12), which is consistent with the reported reliability of the 12-item IBQ-NA.

Table 11

Non-Applicable Response Frequencies and Percentages in the IBQ-Negative Affect Subscale (IBQ-NA)

IBQ-NA item question	"Not-applicable" response	
	Frequency	%
3. When tired, how often did your baby show distress?	8	6
4. When introduced to an unfamiliar adult, how often did the baby cling to a parent?	37	29
9. When it was time for bed or a nap and your baby did not want to go, how often did s/he whimper or sob?	23	18
10. After sleeping, how often did the baby cry if someone doesn't come within a few minutes?	6	5
16. How often did the baby seem angry (crying and fussing) when you left her/him in the crib?	7	5
17. How often during the last week did the baby startle at a sudden change in body position (e.g., when moved suddenly)?	10	8
22. At the end of an exciting day, how often did your baby become tearful?	27	21
23. How often during the last week did the baby protest being placed in a confining place (infant seat, play pen, car seat, etc.)?	5	4
28. When introduced to an unfamiliar adult, how often did the baby refuse to go to the unfamiliar person?	34	26
29. When you were busy with another activity, and your baby was not able to get your attention, how often did s/he cry?	18	14
32. When the baby wanted something, how often did s/he become upset when s/he could not get what s/he wanted?	33	26
33. When in the presence of several unfamiliar adults, how often did the baby cling to a parent?	38	30

Note. IBQ = Infant Behavior Questionnaire (Gartstein & Rothbart, 2003; Putnum et al., 2006).

Table 12

Final Corrected Item-Totals of the IBQ-Negative Affect Subscale(IBQ-NA)

Subscale item question	Item total correlation
3. When tired, how often did your baby show distress?	.493
9. When it was time for bed or a nap and your baby did not want to go, how often did s/he whimper or sob?	.489
10. After sleeping, how often did the baby cry if someone doesn't come within a few minutes?	.539
16. How often did the baby seem angry (crying and fussing) when you left her/him in the crib?	.570
17. How often during the last week did the baby startle at a sudden change in body position (e.g., when moved suddenly)?	.406
22. At the end of an exciting day, how often did your baby become tearful?	.524
23. How often during the last week did the baby protest being placed in a confining place (infant seat, play pen, car seat, etc.)?	.499
29. When you were busy with another activity, and your baby was not able to get your attention, how often did s/he cry?	.708
32. When the baby wanted something, how often did s/he become upset when s/he could not get what s/he wanted?	.558

Note. IBQ = Infant Behavior Questionnaire (Gartstein & Rothbart, 2003; Putnum et al., 2006).

Internal consistency reliability for IBQ-Effortful Control Scale (IBQ-EC). Reliability analysis of the subscale items was completed. Only 52 (40%) of participants answered all 12 items in the IBQ-EC subscale. Table 13 shows not-applicable responses (frequency and percent) for each scale item.

Four items had a corrected item-total correlation less than .3 (item eIBQ_11 = -.071, eIBQ_5 = .191, eIBQ_24 = .291, eIBQ_35 = .241; Field, 2005). The resulting 8-item scale had three items with a non-applicable participant response rate less than 15%. Secondly, items with the highest non-applicable responses (sIBQ_19 = 40%; sIBQ_6 = 33%) were evaluated for face validity and removed one at a time, evaluating the effect on the Cronbach's alpha and valid cases

(Darlington & Wright, 2006; Worobey, 1986). The final 6-item scale shows corrected item-total correlations greater than .396 and a resulting Cronbach's alpha of respondents answering all scale items (see Table 14). The Cronbach's alpha for this scale was .708, with 94 (73%) respondents answering all scale items (see Table 14), which is consistent with the reported reliability of the 13-item IBQ-EC.

Table 13

Non-Applicable Response Frequencies and Percentages in the IBQ-Effortful Control Subscale (IBQ-EC)

	"Non-applicable" response	
IBQ-EC item question	Frequency	%
5. How often during the last week did the baby enjoy being read to?	43	33
6. How often during the last week did the baby play with one toy or object for 5-10 minutes?	43	33
11R. In the last week, while being fed in your lap, how often did the baby seem eager to get away as soon as the feeding was over?	11	9
12. When singing or talking to your baby, how often did s/he soothe immediately?	5	4
18. How often during the last week did the baby enjoy hearing the sound of words, as in nursery rhymes?	11	9
19. How often during the last week did the baby look at pictures in books and/or magazines for 5 minutes or longer at a time?	52	40
24. When being held, in the last week, did your baby seem to enjoy him/herself?	1	1
25. When showing the baby something to look at, how often did s/he soothe immediately?	25	19
30. How often during the last week did the baby enjoy gentle rhythmic activities, such as rocking or swaying?	2	2
31. How often during the last week did the baby stare at a mobile, crib bumper or picture for 5 minutes or longer?	20	16
34. When rocked or hugged, in the last week, did your baby seem to enjoy him/herself?	0	0
35. When patting or gently rubbing some part of the baby's body, how often did s/he soothe immediately?	2	2

Note. IBQ = Infant Behavior Questionnaire (Gartstein & Rothbart, 2003; Putnum et al., 2006).

Table 14

Final Corrected Item-Totals for the IBQ-Effortful Control Subscale(IBQ-EC)

Subscale item question	Item total correlations
12. When singing or talking to your baby, how often did s/he soothe immediately?	.510
18. How often during the last week did the baby enjoy hearing the sound of words, as in nursery rhymes?	.589
25. When showing the baby something to look at, how often did s/he soothe immediately?	.449
30. How often during the last week did the baby enjoy gentle rhythmic activities, such as rocking or swaying?	.455
31. How often during the last week did the baby stare at a mobile, crib bumper or picture for 5 minutes or longer?	.396
34. When rocked or hugged, in the last week, did your baby seem to enjoy him/herself?	.438

Note. IBQ = Infant Behavior Questionnaire (Gartstein & Rothbart, 2003; Putnum et al., 2006).

Descriptive statistics for IBQ-R Very Short Form subscales. Scoring procedures from Mary Rothbart Temperament Lab (2011) were followed. The mean score for each scale was computed by summing items in that subscale and dividing by the number of valid maternal responses. The three higher-order temperament-factor-subscale mean scores are shown in Table 15.

Table 15

Sample Values for the IBQ-R Very Short Form Subscales

Measurement	IBQ- 6-item	IBQ-NA 9-item	IBQ-EC 6-item
Sample	126	129	129
Missing data	3	0	0
Mean	3.38	3.45	5.62
Median	3.18	3.22	5.75
Std. deviation	1.71	1.34	.97
Skewness	.241	.386	-.792
Minimum	1.00	1.25	2.17
Maximum	7.00	6.78	7.00
Cronbach's alpha	.862	.834	.708

Note. IBQ-R = revised Infant Behavior Questionnaire IBQ-S: Infant Behavior Questionnaire Surgency Subscale; IBQ-NA: Infant Behavior Questionnaire Negative Affect Subscale; IBQ-EC: Infant Behavior Questionnaire Effortful Control Subscale. Item responses for the scale were forced response: 1 (*never*), 2 (*very rarely [once or twice]*), 3 (*less than half the time*), 4 (*about half the time*), 5 (*more than half the time*), 6 (*almost always*), 7 (*always*), and NA (*does not apply*)

Table 16

Summary of Reliability Coefficients for Study Instruments

Instrument	Number of items	Sample mean	*SD*	Cronbach's α
NCAFScc	13	7.67	2.57	.730
EPDS-3	3	2.02	2.23	.820
IBQ-S	6	3.37	1.70	.862
IBQ-NA	9	3.45	1.34	.834
IBQ-EC	6	5.61	.974	.708

Note. *SD* = standard deviation; α = alpha; NCAFScc=Nursing Child Assessment Feeding scale caregiver contingency subscale; EPDS-3=Edinburgh Postnatal Depression scale; IBQ-S=Infant Behavior Questionnaire, surgency subscale; IBQ-NA=Infant Behavior Questionnaire, negative affect subscale; IBQ-EC=Infant Behavior Questionnaire, effortful control subscale.

Dependent variable: Infant weight gain. Almost all infants (96%) in this sample were first-born children to their mothers; therefore, the accuracy of maternal-reported birth weight is assumed to be acceptable (Seidman et al., 1987; Wilcox et al., 1991). The parent study reported infant weight in pounds and ounces for both birth weight and weight at data collection T1.

Infant weights were converted to kilograms for entry into WHO Anthro. Conversion was computed in SPSS 17 using the following formula: kg = (pounds x 16) x .02831.

The study sample (N = 129) mean birth weight was 3.281 kg, standard deviation was 0.438 kg, and there was a minimum and maximum of 2.467 and 4.423 kg, respectively. Mean infant weight at data collection T1 was 5.005 kg, standard deviation was 1.223 kg, and there was a minimum and maximum of 2.537 and 7.825 kg, respectively.

WAP at birth. The mean WAP at birth was 48%, standard deviation was 29%, and there was a minimum and maximum of 0 and 99% (see Figure 3). Nineteen (15%) infants were born with WAP at or above the 85th percentile. Four infants (3%) were below the 5th percentile.

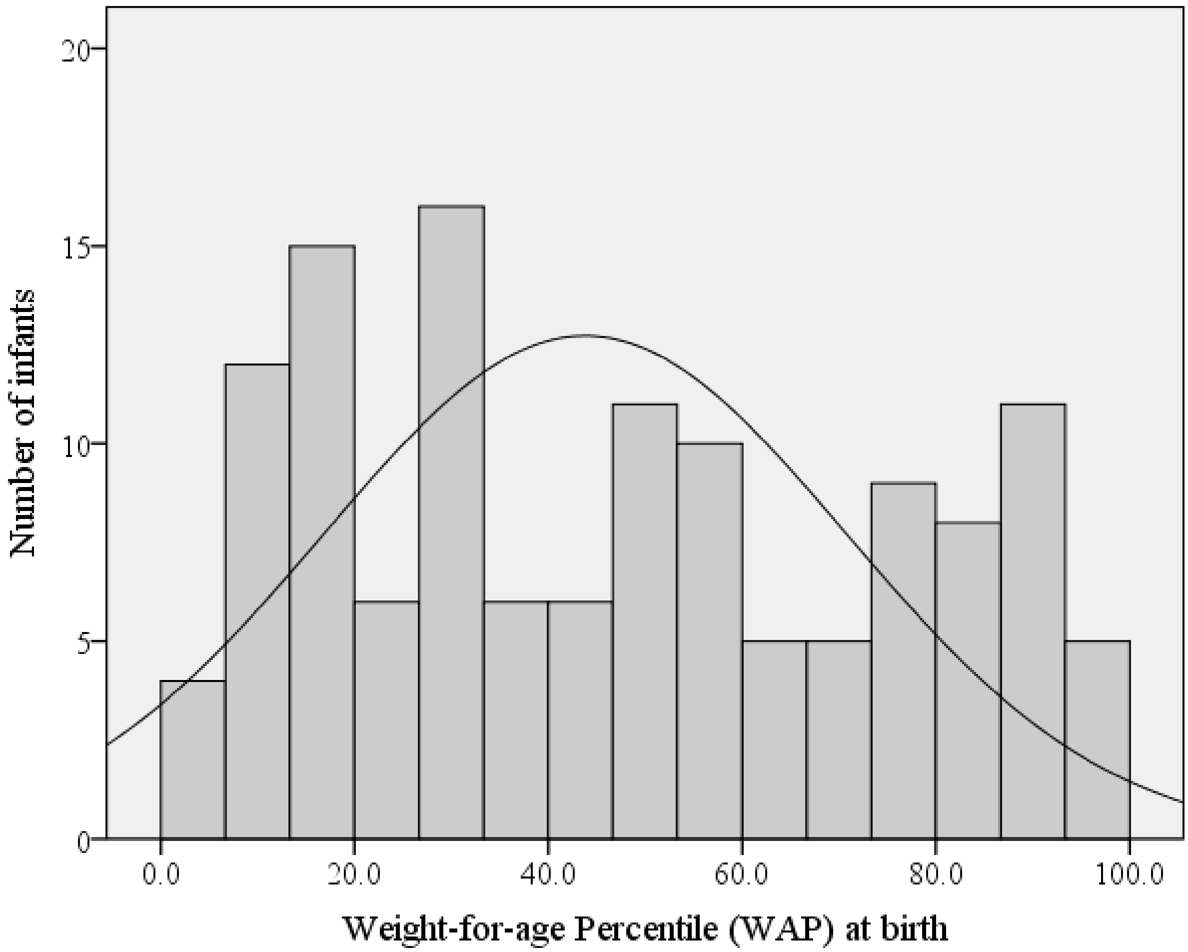

Figure 3. Weight-for-age Percentile (WAP) at birth with a normal distribution curve overlay.

WAP at T1. The mean WAP at T1 was 46%, standard deviation was 28%, and there was a minimum and maximum between 0 and 97% (see Figure 4). Fifteen (12%) infants had a WAP at or above the 85th percentile at T1. Six infants (5%) were below the 5th percentile at T1. Seven (7) infants showed WAP at or above the 85th percentile at both birth and T1. Only one infant showed WAP below the 5th percentile at both birth and T1.

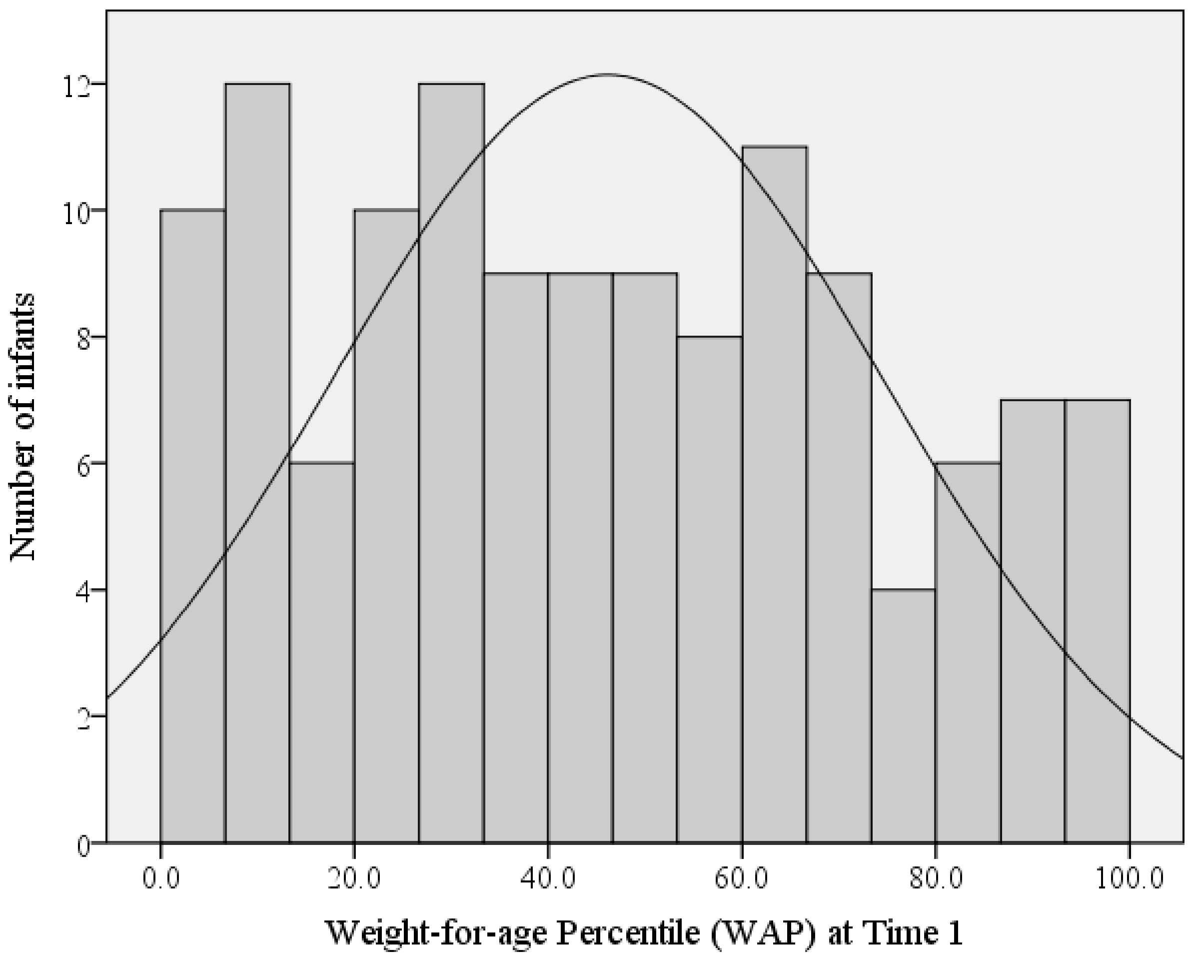

Figure 4. Weight-for-age Percentile (WAP) at Time 1 (T1) with a normal distribution curve overlay.

Infant weight gain in grams per day. Because the T1 data collection took place at different ages, the calculation of relative weight gain from birth to data collection T1 was performed with the following formula: weight in kilograms at data collection T1 minus weight in kilograms at birth, divided by the number of days between birth and data collection T1. The weight gain between birth and data collection T1 was expressed in grams. The mean weight gain per day was 30.442 grams, standard deviation was 10.169 grams, and there was a minimum and maximum of -3.87 grams and 55.87 grams, respectively (see Figure 5).

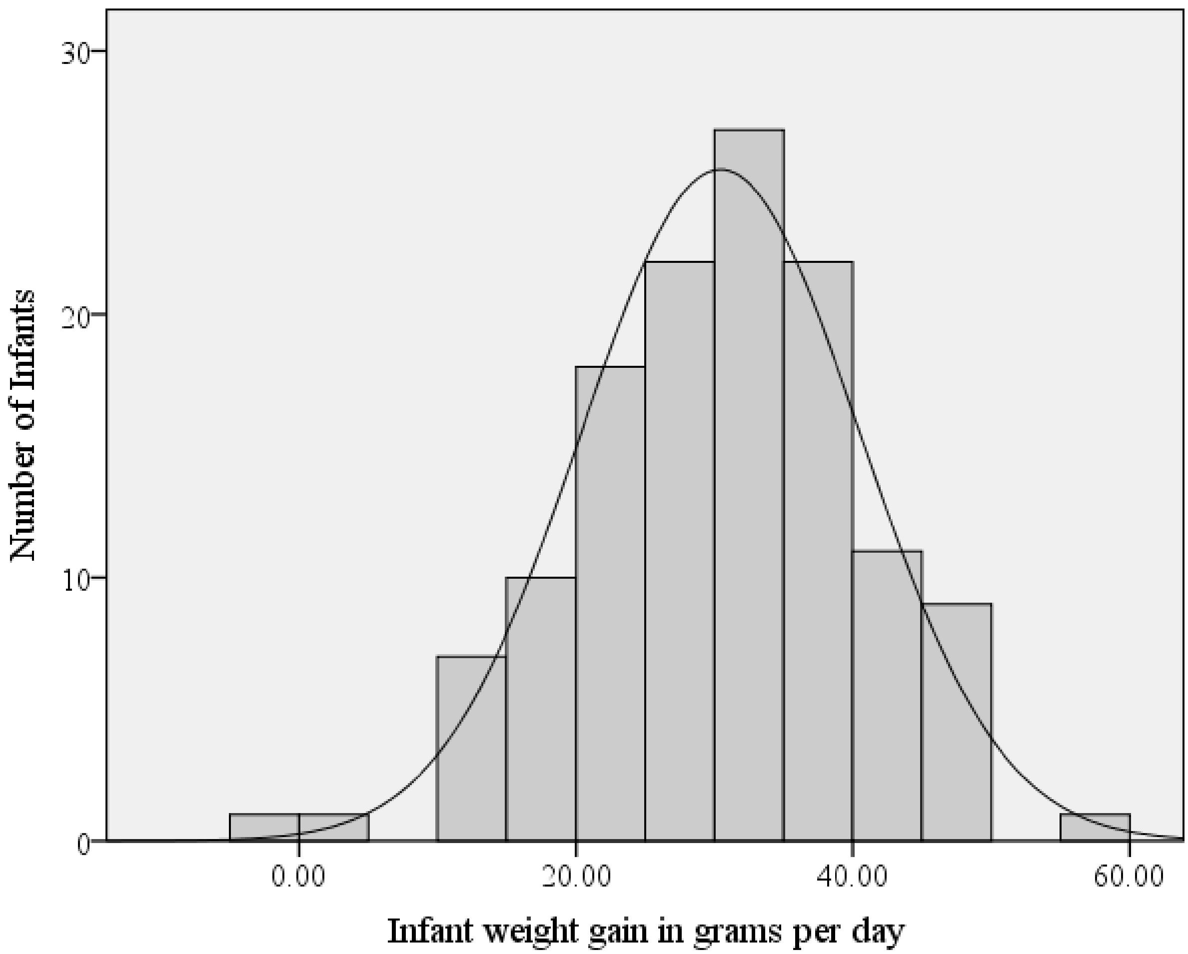

Figure 5. Infant weight gain per day with a normal distribution curve overlay.

RWG. Mean z-score change from birth to T1 was -0.10, standard deviation as 0.84, and there was a minimum and maximum between -2.58 and +2.31 (see Figure 6). The cut-point commonly published for RWG is a gain of more than +0.67 standard deviation between measures. Changes in z-scores were calculated by subtracting birth WAZ from T1 WAZ. Nineteen (15%) infants had a z-score change of +0.67 or higher. Only two infants (1.5%) had downward crossings of two percentile lines.

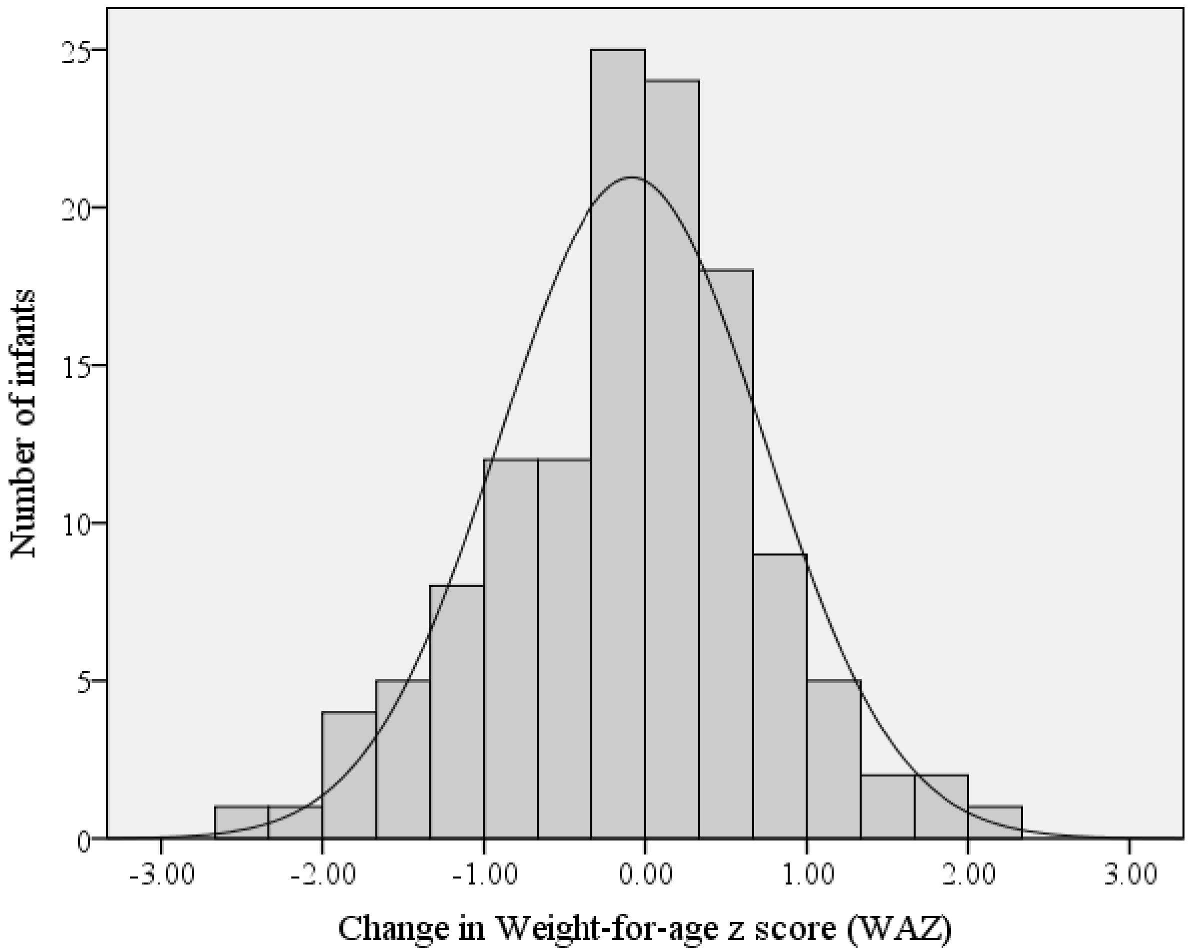

Figure 6. Weight-for-age z-score (WAZ) change from birth to Time 1 (T1) with a normal distribution curve overlay.

Results for Study Aims

The specific aims of this study will be discussed individually in this section.

The correlation analysis, shown in Table 17, was utilized to determine positive or negative relationships between study variables. Infant weight gain in grams per day, infant age and the IBQ-S subscale sores were all positively correlated with RWG. The bottle-feeding method and infant age were negatively correlated with scores on the NCAFScc, and breastfeeding was positively correlated. Other correlations between study variables also existed. Maternal age was negatively correlated with the IBQ-NA subscale, but positively correlated with the IBQ-S subscale. Maternal education was positively correlated with breastfeeding. The breast and bottle-feeding methods were negatively correlated and solid feeding method was positively correlated with infant age. There was a negative correlation between breastfeeding and the score on the IBQ-NA, but a positive correlation between solid feeding and the IBQ-NA. All IBQ-R subscales were positively correlated. EPDS-3 scores and IBQ-NA scores were positively correlated.

Table 17

Correlation Estimates for all Study Variables

	I-wt gain	I-RWG	NCAFScc	M-age	M-EDU	EPDS-3	FM-bot	FM-bre	FM-solid	I-age	I-sex	IBQ-S	IBQ-NA
I-wt gain	1												
I-RWG	.471**	1											
NCAFScc	.114	-.058	1										
M-age	.119	.120	.032	1									
M-EDU	-.027	.051	.003	-103	1								
EPDS-3	.015	.104	.078	-.007	.014	1							
FM-bot	.004	.008	-.335**	-.135	.080	-.001	1						
FM-bre	.046	-.057	.202*	.045	.191*	-.002	-.358**	1					
FM-solid	-.025	.064	-.171	-.114	.094	-.031	.131	-.077	1				
I-age	-.028	.244**	-.191*	.152	.066	.081	.194*	.060	.334**	1			
I-sex	.019	-.075	-.100	-.128	.009	.102	.136	-.075	.041	.092	1		
IBQ-S	.066	.304**	-.054	.222*	-.011	.003	.063	.063	.147	.596**	.005	1	
IBQ-NA	-.149	-.015	-.027	-.185*	.077	.175*	.112	-.255**	.174*	.189*	.224*	.216 *	1
IBQ-EC	-.079	.041	.028	.079	.027	-.010	-.015	.119	.040	.289**	.010	.451 **	.271 **

Note. I-wt gain = Infant's weight gain per day in grams; I-RWG = infant weight gain greater than 0.67 z-scores or rapid weight gain; NCAFScc = Nursing Child Assessment Feeding scale caregiver contingency subscale; M-age = maternal age; M-EDU = Maternal education (0= high school or lower, 1= college); EPDS-3 = Edinburgh Postnatal Depression scale; FM-bot = feeding method bottle (0 = no, 1 = yes); FM-bre = feeding method breast (0 = no, 1 = yes); FM-solid = feeding method solid (0 = no, 1 = yes); I-age = infant age; I-sex = infant sex (0 = female, 1 = male); IBQ-S = Infant Behavior Questionnaire, surgency subscale; IBQ-NA = Infant Behavior Questionnaire, negative affect subscale; IBQ-EC = Infant Behavior Questionnaire, effortful control subscale.

*p < .05

**p < .01

Aim 1. As stated earlier, Aim 1 was to determine to what extent maternal responses to infant feeding cues are associated with infant weight gain in infants from birth to 6 months. Regressions were performed separately for two measures of infant weight gain: (a) multiple linear regressions for infant weight gain per day in grams and (b) logistic regression for the categorical outcome of RWG as the dependent variable, and the independent variables listed above.

Multiple linear regressions for relative infant weight gain. A multiple regression model based on the proposed study framework was run to determine to what extent the predictors, shown in Table 18, would predict relative infant weight gain. To perform the regression analysis, categorical variables were recoded into dummy variables, as noted in Table 21, and all selected variables were entered.

Table 18

Description of Outcome and Proposed Predictor Variables Used in the Regression Models for Aim 1

Variable	Description
Relative infant weight gain (continuous)	Outcome variable: calculated weight gain in grams, per day, from birth to data collection time one
Rapid weight gain (categorical)	Outcome variable: 1 = weight-for-age z score increased more than +0.67 from birth to data collection time one; 0 = weight-for-age z score did not increase more than +0.67 from birth to data collection Time 1
Maternal responses (continuous)	Predictor variable: observational scoring of NCAFS caregiver contingency subscale (NCAFScc)
Maternal age (continuous)	Predictor variable: self-report age in years
Maternal postpartum depressive symptomatology (continuous)	Predictor variable: maternal report, EPDS-3 scale score sum
Maternal education (categorical)	Predictor variable: 0 = high school education or lower and 1 = some college
Feeding method (categorical)	Predictor variable: any bottle-feeding (0 = no, 1 = yes), any breastfeeding (0 = no, 1 = yes), and any solid feeding (0 = no, 1 = yes)
Infant age (continuous)	Calculated in days between birth and data collection Time 1
Infant sex (categorical)	Predictor variable: maternal report, 0 = female and 1 = male
Infant temperament (continuous)	Predictor variable: maternal report using IBQ-R very short form. Three scales (1) IBQ-surgency, (2) IBQ-negative affect, and (3) IBQ-effortful control

Note. NCAFS = Nursing Child Assessment Feeding Scale; EPDS-3 = 3-item Edinburgh Postnatal Depression Scale; IBQ = Infant Behavior Questionnaire.

Case-wise diagnostics showed two (1%) cases with a standard residual less than -2 and more than 2, and one of those was less than -3 (Field, 2005). Data were rechecked for errors; none were noted, although case number 60 was the only infant to show a negative weight gain (-

3.87 g/day). This infant's birth weight (case #60) was at the 90th percentile at birth, dropping to the 38th percentile at 22 days old. Cook's distance was calculated and no cases were shown to have a distance greater than 1 (range = 0-0.069). Mahalanobis distance results ranged between 5.763 and 30.387. A value less than 34.528 is recommended by Tabachnick and Fidell (p.949, 2007) for 13 degrees of freedom (p. 949). Covariance ratios (CVR) were all less than 0.698 (1-[3(12+1)/129]; Field, 2005). The proposed model results are shown in Table 19 and were not found to be significant (R =.286, Adjusted R^2 = .082; F = [12, 112] = .834; p =.615).

Table 19

Linear Regression Model Indicating Significant Predictors of Relative Infant Weight Gain in Grams per Day

	Unstandardized coefficient		Standardized coefficient			Collinearity statistic	
Predictor	B	*SE*	Beta	*t*	Significance	Tolerance	VIF
Constant	26.762	9.091		2.944	.004		
NCAFScc	.562	.393	.141	1.430	.155	.843	1.187
M-age	.250	.239	.105	1.045	.298	.816	1.225
M-EDU	-.857	1.980	-.042	-.433	.666	.883	1.132
EPDS-3	.176	.429	.038	.410	.683	.937	1.067
FM-bot	2.158	2.459	.093	.878	.382	.735	1.360
FM-bre	.520	2.548	.022	.204	.839	.699	1.431
FM-solid	.634	2.046	.031	.310	.757	.830	1.205
I-age	-.029	.034	-.102	-.832	.407	.543	1.840
I-sex	1.425	1.933	.069	.737	.463	.926	1.080
IBQ-S	1.156	.748	.191	1.545	.125	.538	1.858
IBQ-NA	-1.126	.828	-.147	-1.360	.176	.702	1.424
IBQ-EC	-1.310	1.119	-.123	-1.171	.244	.738	1.355

Note. $N = 125$; $R^2 = .082$; $F = (12, 112) = .834$; $p = .615$. Dependent Variable: infant weight gain per day in grams. *SE* = standard error; *t* = t-distribution; VIF = variance inflation factor; NCAFScc = Nursing-Child Assessment Feeding Scale Caregiver Contingency scale; M-age = maternal age; M-EDU = Maternal education (0 = high school or lower; 1 = college); EPDS-3 = Edinburgh Postnatal Depression scale; FM-bot = feeding method bottle (0 = no, 1 = yes); FM-bre = feeding method breast (0 = no, 1= yes); FM-solid = feeding method solid (0 = no, 1 = yes); I-age = infant age; I-sex = infant sex (0 = female, 1 = male); IBQ-S = Infant Behavior Questionnaire, surgency subscale; IBQ-NA = Infant Behavior Questionnaire, negative affect subscale; IBQ-EC = Infant Behavior Questionnaire, effortful control subscale

RWG logistic regression results. A logistic regression model based on the proposed study framework was run to determine to what extent the predictor variables, shown in Table 21, would predict RWG. Infant weight change was dummy-coded into two groups; those identified as having RWG and those who did not. Based on literature, RWG was defined as a z-score increase of 0.67.

Logistic regressions were performed: RWG as the dichotomous dependent variable with NCAFScc, maternal age, maternal education, EPDS-3, feeding method, infant age, infant sex, and infant temperament. The block 0 analysis (includes no predictor variables, just the intercept) overall percentage in which the values of the dependent variable were predicated was 84.8% (RWG predicated by the null model was 0%). The overall percentage of dependent variable values predicted by the second step of the analysis (block 1) was 86.4%. (RWG predicted by the full model increased to 15.8%). Based on the full model, 105 infants were observed to be without RWG and were correctly predicted to be without RWG; only three infants were observed to have RWG and were correctly predicted to have RWG. One infant observed to be without RWG was predicted to have RWG, and 16 infants were observed with RWG but were predicted to not have RWG (see Table 20). The Omnibus test (x^2 = 21.187; *df* = 12; *p* = .048) of the full model was minimally significant. Table 21 shows the coefficients and odds ratios for the full logistic regression model.

The log-odds units (B) are the values in the logistic regression equation for predicting the dependent variable from the independent variables. These estimates tell the amount of increase (or decrease) in the predictor, holding all other predictors constant. In this model, the only independent variable to show significance was the IBQ-S subscale. For every one-unit increase in the IBQ-S subscale score, we expected a 0.698 increase in the log-odds of RWG, holding all other independent variables constant. The odds of RWG occurring increased 2-fold with every one-unit increase in IBQ-S subscale score.

Table 20

Overall Percentage of Dependent Variable Values Predicted by the Second Step of the Logistic Regression Analysis

Step 1	Observed	Predicted		Percentage correct
		Weight gain over 0.67		
		RWG (no)	RWG (yes)	
	RWG (no)	105	1	99.1
Weight gain over 0.67	RWG (yes)	16	3	15.8
Overall Percentage				86.4

Note. RWG = rapid weight gain

Table 21

Independent Variables of Maternal and Infant Characteristics with RWG as the Dependent Variable for Logistic Regression Analysis

Included	B	*SE*	Sig.	Exp (B)	95% CI for exp (B)	
					Lower	Upper
NCAFScc	-.014	.112	.900	.986	.791	1.229
M-age	.022	.062	.727	1.022	.904	1.155
M-EDU (1 = college, 0 = HS)	-.457	.635	.472	.633	.182	2.198
EPDS-3	.162	.126	.199	1.176	.918	1.506
FM-bot (1 = yes, 0 = no)	.501	.798	.530	1.651	.345	7.885
FM-bre (1 = yes, 0 = no)	1.159	.823	.159	3.186	.635	15.982
FM-solid (1 = yes, 0 = no)	.005	.642	.994	1.005	.285	3.538
I-age	.007	.009	.420	1.007	.990	1.025
Sex (1 = male, 0 = female)	.226	.590	.702	1.253	.394	3.983
IBQ-S	.698	.254	.006	2.009	1.220	3.309
IBQ-NA	-.311	.272	.254	.733	.430	1.249
IBQ-EC	-.502	.403	.213	.605	.275	1.333
Constant	-2.079	2.359	.378	.125		

Note. B = intercept or odds ratio; *SE* = standard error; Sig = significance; Exp (B) = exponentiation of the B coefficient; CI = confidence interval; NCAFScc = Nursing-Child Assessment Feeding Scale Caregiver Contingency scale; M-age = maternal age; M-EDU = Maternal education (HS = high school); EPDS-3 = 3-item Edinburgh Postnatal Depression scale; FM-bot = feeding method bottle; FM-bre = feeding method breast; FM-solid = feeding method solid; I-age = infant age; I-sex = infant sex; IBQ-S = Infant Behavior Questionnaire, surgency subscale; IBQ-NA = Infant Behavior Questionnaire, negative affect subscale; IBQ-EC = Infant Behavior Questionnaire, effortful control subscale.

Aim 2. Multiple regressions were run to determine to what extent maternal characteristics (age, depressive symptomatology, education, and feeding method) were associated with maternal responses to infant feeding cues. Regressions were performed with the maternal response measure (NCAFScc) as the dependent variable, and with maternal age, maternal postpartum depressive symptomatology, maternal education, and feeding method as independent variables. To perform regression analysis, categorical variables were recoded into dummy variables, as noted in Table 22, and all selected variables were entered.

Table 22

Description of Outcome and Predictor Variables Used in the Regression Model for Aim 2

Variable	Description
Maternal responses (continuous)	Outcome variable: NCAFS caregiver contingency subscales mean score.
Maternal age (continuous)	Predictor variable: self-report age in years
Maternal postpartum depressive symptomatology (continuous)	Predictor variable: maternal report. EPDS-3 scale score sum
Maternal education (categorical)	Predictor variable: 0 = high school education or lower and 1 = some college
Feeding method (categorical)	Predictor variable: any bottle-feeding (0 = no,1 = yes), any breastfeeding (0 = no, 1 = yes), and any solid feeding (0 = no, 1 = yes)

Note: NCAFS: Nursing Child Assessment Feeding Scale; EPDS-3= 3-item Edinburgh Postnatal Depression Scale.

Case-wise diagnostics showed six (5%) cases with a standard residual less than -2 and greater than 2 (Field, 2005). Cook's distance was calculated and no cases were shown to have a distance greater than 1 (range = 0-0.60). Mahalanobis distance results ranged between 2.76 and 25.25. A value less than 22.45 is recommended by Tabachnick and Fidell (2007) for six degrees of freedom (p. 949). Only one such case existed, with a value of 25.25. This case (#19) had a

CVR of 0.199, which was less than 7.83 (1-[3(6+1)/129]; Field, 2005). The evidence suggests there were no influential cases within our data run for this regression analysis.

Altogether, 14% (*R* = .379, adjusted R^2 = .144, *F* = [6, 127] = 3.325, *p* = .005) of the variability in NCAST-F/PCI-F scores was predicted by knowing the responses to these independent variables (see Table 23). However, feeding method was the only significant predictor. The size and direction of the relationship suggests that mothers who bottle-fed tended to have lower total scores on the NCAFScc.

Table 23

Linear Regression Model Indicating Significant Predictors of Maternal Responsiveness Measured by the NCAFS Caregiver Contingency Subscale (NCAFScc).

Variable	Unstandardized coefficient		Standardized coefficient			Collinearity statistic	
	B	*SE*	Beta	*t*	Significance	Tolerance	VIF
Constant	9.128	1.417		6.444	.000		
M-age	-.022	.052	-.037	-.426	.671	.950	1.052
M-EDU	.148	.457	.029	.324	.747	.903	1.107
EPDS-3	.083	.098	.072	.852	.396	.995	1.005
FM-bot	-1.739	.538	-.301	-3.231	.002	.816	1.226
FM-bre	.462	.549	.078	.841	.402	.813	1.230
FM-solid	-.648	.444	-.125	-1.460	.147	.962	1.039

Note. *N* = 128; Adjusted R^2 = .144; *F* = (6, 127) = 3.380; *p* = .004. Dependent variable: NCAFS caregiver contingency subscale (NCAFScc). *SE* = standard error; *t* = t-distribution; VIF = variance inflation factor; M-age = maternal age; M-EDU = Maternal education (0 = high school or lower, 1 = college); EPDS-3 = Edinburgh Postnatal Depression scale; FM-bot = feeding method bottle (0 = no, 1 = yes); FM-bre = feeding method breast (0 = no, 1 = yes); FM-solid = feeding method solid (0 = no, 1 = yes); NCAFS = Nursing-Child Assessment Feeding Scale.

Aim 3. Regressions were run to determine to what extent infant characteristics (age, sex, and temperament) were associated with maternal responses to infant cues. Regressions were performed for the maternal response measures (NCAFScc) as the dependent variable, and infant age, infant sex, and infant temperament (three IBQ subscales) as independent variables. To perform regression analysis, categorical variables were recoded into dummy variables, as noted in Table 24, and all selected variables were entered.

Table 24

Description of Outcome and Predictor Variables Used in the Regression Model for Aim 3

Variable	Description
Maternal responses (continuous)	Outcome variable: NCAFS caregiver contingency subscales mean score
Infant age (continuous)	Predictor variable: calculated in days between birth and data collection time one
Infant sex (categorical)	Predictor variable: maternal report 0 = female, 1 = male
Infant temperament (continuous)	Predictor variable: maternal report using IBQ-R very short form. Three scales (1) IBQ-surgency, (2) IBQ-negative affect, and (3) IBQ-effortful control

Note. NCAFS: Nursing Child Assessment Feeding Scale; IBQ: Infant Behavior Questionnaire.

Case wise diagnostics showed five (4%) cases with a standard residual less than -2 and greater than 2 (Field, 2005). Cook's distance was calculated and no cases were shown to have a distance greater than 1 (range = 0-.171). Mahalanobis distance results ranged between 1.36 and 15.84. A Mahalanobis value less than 16.266 is recommended by Tabachnick and Fidell (p .001) for five degrees of freedom (2007, p. 949). The CVRs were not less than 0.861 (1-[3(5+1)/129]; Field, 2005). The evidence suggests there were no influential cases within our data run for this regression analysis.

This regression model was not significant (R = .219, Adjusted R^2 = .048, F = [5, 120] = 1.211, p = .308; see Table 25). Two predictors within the model were significant. As age of the infant increased, the NCAFScc scores decreased (see Appendix C). As the score on the IBQ-NA subscale increased, the score on the NCAFScc decreased (see Appendix D)

Table 25

Linear Regression Model Indicating Significant Infant Predictors of Maternal Responsiveness Measured by the NCAFS Caregiver Contingency Subscale (NCAFScc)

Variables	Unstandardized coefficient		Standardized coefficients			Collinearity statistic	
	Beta	*SE*	Beta	*t*	Significance	Tolerance	VIF
Constant	7.544	1.356		5.563	.000		
I-age	-.019	.008	-.270	-2.457	.015	.626	1.597
I-sex	-.257	.451	-.050	-.570	.569	.982	1.019
IBQ-S	.091	.176	.060	.518	.606	.557	1.797
IBQ-NA	.801	.325	.307	2.464	.015	.486	2.056
IBQ-EC	-.381	.344	-.143	-1.109	.270	.455	2.200

Note. R = .219; Adjusted R^2 =.048; F = (5, 120) = 1.211; p = .308.Dependent variable: NCAFS caregiver contingency subscale (NCAFScc). *SE* = standard error; *t* = t-distribution; VIF = variance inflation factor; I-age = infant age at data collection; I-sex= infant sex (0 = female, 1 = male); IBQ-S = Infant Behavior Questionnaire, surgency subscale; IBQ-NA = Infant Behavior Questionnaire, negative affect subscale; IBQ-EC = Infant Behavior Questionnaire, effortful control subscale.

Summary

Aim 1 regression model using maternal responses to infant feeding cues and maternal and infant characteristics during the maternal-infant interaction did not predict infant weight gain; however, using logistic regression and RWG as the dichotomous dependent variable, a minimally significant result (p = .048) was seen using the proposed model to predict the odds of RWG.

Aim 2 regression model using the proposed maternal characteristics explained 14% of the variability in Nursing Child Assessment Satellite Training Tool Caregiver Contingency Subscale (NCAFScc) scores. Maternal responses to infant feeding cues were observed less often in maternal-infant interactions where the feeding method used was a bottle. Maternal characteristics of age, education, and postpartum depressive symptomatology were not significant predictors within the regression model.

Aim 3 regression model using the proposed infant characteristics was not found to be significant. Two characteristics, infant age and infant temperament (negative affect), were significant. As infant's age increased, NCAFScc scores declined, and as scores on the Infant Behavior Questionnaire -negative affect scale increased, NCAFScc scores declined.

Results of this analysis of secondary data were presented in this chapter. In chapter 3, the study framework proposed that the maternal-infant feeding interaction was influenced by maternal and infant characteristics and the interaction of maternal responses to infant feeding cues influenced infant weight gain. Further discussion and implications of these results will be presented in chapter 6.

Chapter 6

Discussion and Implications

Discussion and implications of the results described in chapter 5 will be presented in this final chapter. Discussion will be focused on the interpretation of the findings from the three study aims and validation from the current literature. Infants who are overweight or exhibit RWG in early infancy are at a greater risk of developing obesity later in life (Ogden et al., 2010; Traveras et al., 2009). According to the 2007-2008 National Health and Nutrition Examination Survey, one third of children between 2 and 19 are overweight or obese; 29.3% of Caucasian children, 35.9% of African American children, and 38.2% of Hispanic children (Ogden et al., 2010). The childhood obesity epidemic has sparked renewed interest in identifying risk-factors in early infancy, and literature has suggested a starting point of infant feeding practices, specifically maternal responsiveness associated with infant overweight between the ages of birth and 6 months (Barnard et al., 1989; Dennison et al., 2006; Dubois & Girard, 2006; Goodell et al., 2009; Sacco et al., 2007). Maternal responsiveness in the maternal-infant interaction has been associated with infant social and cognitive development for more than half a century. The maternal-infant interaction, specifically maternal responsiveness during feeding, has been thought to be a critical factor in weight gain, but limited studies have focused on the relationship of maternal responsiveness and infants, age birth to 6 months, who are showing RWG. This study was designed to explore the relationship between maternal responsiveness and early infant weight gain compared to the WHO growth standard in a sample of low-income mother-infant dyads, using data from the parent study. Existing data were used to explore maternal feeding practices and behaviors thought to influence weight gain in infants ages birth to 6 months. In this chapter, an interpretation of the study findings, discussion of study limitations, and implications for nursing research practice and policy will be presented.

Discussion of Results of Aim 1

The first aim was to determine to what extent maternal behavior in response to infant feeding cues is associated with infant weight gain in infants from birth to 6 months. Regressions were run twice with different weight-related outcomes for this aim: (a) relative infant weight gain in grams per day and (b) RWG. A brief discussion of the outcome variable will begin this discussion.

It is anticipated that an infant will gain, on average, between 140 and 200 g per week (20-28.57 g/day) for the first six months and then between 85 and 140 g per week (12.14-20 g/day) for the next three months (Ball et al., 2012). In this study, infants gained, on average, 30.44 grams per day (*SD* = 10.17), which was slightly higher than expected. Infants with RWG tended to gain more weight (*M* =41.9 g/day, *SD* = 7.48) than infants who did not meet the criteria for RWG (*M* = 28.5 g/day; *SD* = 9.23).

The first regression model using predictive variables of maternal responsiveness, maternal and infant characteristics with relative infant weight gain, was shown not to be predictive of infant weight gain in grams per day (p = .615).

A logistic regression model was used to predict RWG and was found to be minimally significant (p = .048); however, only three of 19 infants with RWG were correctly identified (105 of 106 infants without RWG were correctly identified). This result is reported with caution because only one predictor, the infant temperament subscale for surgency (IBQ-S subscale score), was significant in the logistic regression model: For every one-unit increase in IBQ-S score, the odds of RWG occurring increased 2 fold in this sample. Surgency is one of three higher order infant temperaments measured by the IBQ-R very short form. An infant with higher surgency would tend to be more reactive with his or her environment; the infant may smile more, be more vocal or express pleasure more often (Putnum et al., 2006).

Concerns were raised in chapter 5 regarding the IBQ-R very short form because of the high number of missing or non-applicable responses. According to Worobey (1986), the full 90-question IBQ is capable of measuring aspects of temperament in infants younger than 3 months of age; however, item reduction due to non-applicable response was necessary. In a more recent study, Darlington and Wright (2006) used the full 90-item IBQ with 75 British mothers of 8-week-old infants. The researchers reduced the full (90 item) IBQ to 47 items (excluding any item with greater than a 15% non-applicable response rate). The infant population in this study may have been too young to reflect an accurate measure of temperament using this IBQ-R very short form questionnaire. The IBQ was revised into a very short form and tested in infants 3 months of age and older (Helbig et al., 2009). A majority of this sample (*n* = 102; 79%), were 3 months or younger. Therefore, the minimally significant result of the proposed logistic regression model run for Aim 1 is reported with caution and should be reevaluated in a larger sample with less infant age variability.

It was hypothesized that maternal responses to infant feeding cues is observed less often in infants with RWG, which was not supported in the analysis of Aim 1. There were only 19 (15%) infants in this study sample showing RWG and currently, there is limited published data on prevalence of RWG defined as a z-score increase of 0.67 between two weight measures in time. Ong (2010) proposed that as many as 25% of infants will show RWG (z-score change of +0.67) in the first two years of life. Given this statistic, the prevalence of RWG in this sample of 15% may be of interest in understanding the patterns of RWG. Secondly, there is a possibility that more infants would have shown RWG in this sample as they age. The median infant age for this study was 45 days. Seventeen (85%) of the infants, identified in this study as having RWG, were over 45 days old. If the prevalence of RWG remains the same in infants under that age of 45 days of age as it was for infants over 45 days of age, RWG prevalence in this study population could reach nearly 30%. This study provided a basis for future research focused on RWG, as well as implications for nursing practice in early recognition of risk factors for childhood obesity, which will be presented in future sections of chapter 6.

Discussion of Results for Aim 2

The second aim of this analysis was to determine to what extent maternal characteristics (age, education, postpartum depressive symptomatology, and feeding method) are associated with maternal responses to infant feeding cues. The regression model using the proposed maternal characteristics was significant in predicting 14% of the variability in NCAFScc scores (N = 128, R = .379; adjusted R^2 = .144, F = [6, 127] = 3.325, p = .005). Only one of the maternal characteristics in the proposed model (bottle-feeding method) was significant. Maternal responses to infant feeding cues were observed less often in maternal-infant interactions where the feeding method used was a bottle. Each of the variables used in Aim 2 will be discussed individually.

Maternal responsiveness. In the parent study, the maternal-infant feeding interaction was measured by video observations coded by two trained and reliable NCAST-F/PCI-F coders. For this study, the NCAFScc was used to measure maternal responses to infant feeding cues, and the average score was 7.67. Expected scores for the NCAFScc have been reported between 12.87 for Caucasian (N = 791), 12.82 for African American (N = 431), and 12.30 for Hispanic mothers (N = 301; Barnard et al, 1989; Sumner & Spietz, 1994). Given that two scale items were removed, the average scores in this sample were still below the expected average according to the NCAST feeding manual.

Overall, maternal responses to infant feeding cues were observed less often in this study population. One of the main goals of the parent study was to provide maternal education to enhance maternal responsiveness (Horodynski et al., 2011), which is generally lower in low-income mothers (Barnard et al, 1989; Sumner & Spietz, 1994). Maternal responsiveness has been thought to be foundational to healthy infant eating patterns (Horodynski et al., 2011; Johnson & Birch, 1994; Pridham et al,. 2010; Sacco et al., 2007), cognitive growth (Aboud et al., 2009; Donovan & Leavitt, 1978), and attachment (Ainsworth, 1969b). It is worrisome that this sample had lower than expected scores on the NCAFScc because this places the infant, in this dyad, at risk.

Maternal age. In this study, the average maternal age was 22 years old. The average maternal age in the U.S. for a first birth is 25 years old, last reported from 2006 data (HRSA, 2011). In comparison to the 2006 HRSA reports, this sample is younger than average for first time birth for Caucasian, Hispanic and African American mothers. The majority of women in this sample were between 20 and 24 years of age, whereas the majority of first-time mothers in the 2006 HRSA report were between 25 and 34 years of age. Eighty-one percent of this maternal sample was less than 24 years of age, with 50% being between 20 and 24 years of age.

In general, the mothers in this sample were younger than the reported national average for first births. In this sample, maternal age did not appear to predict NCAFScc scores, which was used in this study to measure maternal responses to infant feeding cues. It was questionable, from the literature, whether maternal age would have any association between maternal responses to infant feeding cues, because the parent study did not include mothers younger than 18 years of age.

Maternal education. A large percentage (47%) of mothers in this study had an education past high school. Only 20% of the participants reported not graduating from high school. The National Center for Education Statistics (2010) reported that high school graduation completion rates for 2008 were 90% overall for females, 95% for White females, 85% for non-Hispanic Black females, and 78% for Hispanic females. A low correlation (.191) was seen between breastfeeding method and the education category of more than a high school education; this means that mothers with some college education had a higher tendency to be breastfeeding. This finding was supportive of national trends; breastfeeding rates tend to be higher in women with higher education (CDC, 2011, Infant Feeding Practices Study II). In this sample, education did not appear to predict maternal responses to infant feeding cues measured by the NCAFScc scores.

Maternal postpartum depressive symptomatology. The EPDS-3 was used by the parent study to measure postpartum depressive symptomatology. The EPDS-3 contained three of the 10 questions from the EPDS, which is used to screen for postpartum depressive symptomatology. More than half of this sample (64%) scored 10 or less, which was considered to be the cut-off point for referral by this screening tool. The prevalence of diagnosed PPD reported in the literature is between 10% and 15%, with significantly higher rates seen in at-risk populations such as lower income families (Beck, 1995; Dennis & McQueen, 1990; Tronick & Reck, 2009). Thirty-six (36%) percent of this sample was at-risk for PPD according to this screening tool. The EPDS-3 is considered an ultra-brief alternative to the full EPDS and has been identified as the anxiety subscale of the full EPDS (Kabir et al., 2008). The use of secondary data did not provide a means to evaluate or confirm a diagnosis of PDD through a psychiatric interview. It is possible that the EPSD-3 identified other mental health problems, such as an anxiety disorder.

In this sample, postpartum depressive symptomatology, measured by the EPSD-3, did not appear to predict maternal responses to infant feeding cues measured by the NCAFScc. Because the literature tended to agree that higher postpartum depressive symptomatology influenced maternal responsiveness, use of the 10-item EPDS may have captured more depressive symptomatology dimensions and been influential in this analysis.

Feeding method. In this sample, the bottle-feeding method was a significant predictor ($p = .002$) of maternal responses to infant feeding cues measured by the NCAFScc, although the model only explained 14% of the variability. Maternal responses were observed less often in bottle-feeding mothers.

Responsive maternal behavior has been described as synchronous, reciprocal exchanges or expressions between mother and infant. This description of responsiveness is a key component of the authoritarian feeding styles, which is a feeding style where the mother is less responsive to infant's cues of hunger and satiety and is intent on controlling the feeding interaction (Baurrind, 1966; Hughes et al., 2005; Sacco et al., 2007). Several reviews have been conducted on parental feeding styles, and the one thing they have agreed on is a balance of control between mother/parent and infant/child (Baumrind, 1966; Costanzo & Woody, 1985; Eneli, Crum, & Tylka, 2008; Faith et al., 2004; Sleddens, Gerards, Thijs, de Vries, & Kremers, 2011).The finding that maternal responses were observed less often in bottle-feeding mothers is worrisome for two reasons. First, a majority of mothers chose to bottle feed. Second, if what the infant learns through the maternal-infant feeding interactions has a role in establishing infant eating patterns (Lamb, 1981; Wright, Fawcett & Crow, 1980), identification of specific maternal response patterns, seen in overweight infants may be important in understanding the development of childhood obesity.

Early infant feeding interactions are focused on the relief of *hunger distress* and the development of sociability and personality (Lamb, 1981). Tactile, motor, facial and vocal-emotional signals are interventions utilized by the mother to reduce distress and to construct appropriate behavior regulation in the infant (Mumme, Fernald, & Herrera, 1996). These maternal responses are observable by the infant during feeding, and there is an opportunity for these maternal responses to establish an expectation for the infant while eating.

The choice of bottle-feeding may have two consequences. Researchers have suggested that breastfeeding offers lower levels of maternal control compared to feeding by bottle (DiSantis, Collins, Fisher, & Davey, 2011). Research also suggests that bottle content, specifically formula, may increase infant weight gain (Ekelund et al., 2006; Singhal et al., 2010). Bottle-feeding is an artificial system of infant feeding historically designed to provide and measure nutritional intake when the maternal means of feeding (e.g., breastfeeding) were unavailable. The bottles allow the caregiver to visualize the content or amount available to the infant. Bottle-feeding is distinctly different from breastfeeding because bottle-feeding offers the visual cue of volume (e.g., a mother can visually measure the number of ounces the infant takes with each feeding). Although this may seem desirable, the *bottle cue* may be in direct competition with the infant’s own self-regulating cues of hunger and satiety. The visual cue bottle-feeding provides can potentially transfer the determination of satiation from the infant’s cues to the bottle volume (Kavanaugh, Cohen, Heinig, & Dewey, 2010; Lavelli & Poli, 1998; Wright, 1988). This study provides a starting point for further research. Further research is needed to understand the decision-making process, not just the observed responsiveness, seen in bottle-feeding mothers. The assumption stated above, that the bottle acts as a visual cue, may be inaccurate; qualitative research is needed to explore the decision-making process used by bottle-feeding mothers.

In summary, this study proposed that maternal age, education, depressive symptomatology, and feeding method are predictive of maternal responses to infant feeding cues. Although, the regression model was significant, only the bottle-feeding method was shown to be a significant predictor. Because bottle-feeding continues to be the most common feeding practice, especially in low-income mothers of infants, it will be important to encourage mothers to respond to their infants' cues more effectively. This study sample indicates that maternal responses to infant feeding cues are observed less often in bottle-feeding mothers, signifying these mothers may be missing important self-regulating cues from the infant during feeding.

Discussion of Results of Aim 3

The third aim was to determine to what extent infant characteristics (age, sex, and temperament) are associated with maternal responses to infant feeding cues. The model was not significant in predicting observed maternal responses (R = .219, adjusted R^2 = .048, F = [5, 120] = 1.211, p = .308). Two infant characteristics were significant within the model: infant age (p = .015) and the IBQ-NA (p = .015). Maternal responsiveness was observed less often in older infants and those identified by their mother as having a lower negative affect score for temperament.

Infant ages in this study sample ranged between 10 days and 152 days old (M = 57, SD = 37). As mentioned earlier, a majority of the infant sample was under 3 months of age (N = 102, 79%). According to the literature, changes in fine and gross motor development, as well as cognition and language development, occur over a short period of time for infants (Ball et al., 2012). It was assumed that older infants would communicate their feeding cues more clearly as their age increased, and NCAFS scores were reported to increase as infant age increased (Barnard et al., 1989). In this study, the opposite was seen: As infant age increased, maternal responsiveness decreased (see Appendix D). A possible explanation for this trend could be bottle-feeding, which had a low correlation with infant age (.194); bottle-feeding, as the feeding method, increased as infant age increased. This finding reenforces the need to measure maternal responsiveness in bottle-feeding mothers, ideally using a longitudinal design between the ages of birth and 6 months.

The literature indicated that maternal responsiveness is negatively affected by an infant perceived, by the mother, to have a difficult temperament (Else-Quest et al., 2006; Rothbart, 1982). The negative affect temperament describes an infant that is harder to be around because his or her personality tends to be dominated by fear, anger, and sadness (Putnum et al., 2006). Further concerns about infant age and the temperament subscales will be discussed in the section on strengths and limitations.

Study Limitations

Study limitations are those characteristics of the design or methodology that may influence the findings and conclusions of this study. This study was based on secondary analysis of existing data limited to lower income African American, Caucasian, and Hispanic mother-infant dyads.

Use of the WHO infant growth chart as the comparison for infant weight gain was both a strength and limitation. As a limitation, the WHO growth chart represents standard or ideal infant growth, regardless of race, ethnicity, and nationality, based on breastfed infants. The reference population used to develop the comparison growth chart is an important consideration in this study because a majority of the mother-infant dyads used the bottle-feeding method (Grummer-

Strawn, Reinold, & Krebs, 2010). It could be that the prescriptive approach in describing how infants should grow is not reflective of how infants in the sample do grow. As a strength, it should be noted that the WHO growth chart represents the current evidence-based-practice recommendations of the AAP, CDC and WHO, that infants should be breastfed exclusively to 6 months of age (Krebs & Jacobson, 2003), and is recommended as the comparison chart for infants under 24 months of age by the CDC (2011).

Limitations also include threats to validity in measurement which consist of content, criterion, and construct validity of the measurement tools (Stommel & Wills, 2004). The EPDS-3 is limited to measuring postpartum anxiety, a prominent feature of PPD. Although “the psychometric properties of the 3-item anxiety subscale of the EPDS were comparable to those of the full 10-item scale (α = .78 and .89, respectively)” (Kabir, et. al., 2008, p.699), this study was limited to measuring only the anxiety symptomatology associated with PPD. Other aspects of postpartum depressive symptomatology may have been missed utilizing this abbreviated subscale of the EPDS, but this was not a major focus of the parent study and, therefore, no further data were available to measure this construct in the dataset.

The measurement of infant temperament is of concern. Although good reliability scores were reached for all scales used to measure infant temperament (IBQ-R very short form subscales), a large percentage of items were noted to have not-applicable responses and those reliabilities were based on about half of the study population. Perhaps the questions used to measure the higher order temperaments are not developmentally valid for the range of ages contained in this sample. Exploratory factor analysis and reevaluation of content validity are recommended in a larger sample with less age variability to establish factorial invariance between age groups, especially in infants younger than 3 months of age.

The last measurement tool to consider is the NCAFS. A strength of the NCAFS tool is that it has been used in multiple studies since its inception in the early 1970s to measure the quality of the maternal-infant interaction. Secondly, NCAFS coders are tested yearly by NCAFS productions for continued certification and reliability. However, the feeding observation was limited to one maternal-infant interaction that was video recorded in the mother's home. Video quality, timing, and intrusiveness may have influenced maternal responsiveness to her infant during this taped interaction. Although most feeing interactions were noted to be a typical feeding, the one-time observation may not have been a typical feeding for that dyad.

Implications for Nursing Practice and Education

Nurses in hospitals, clinics, and private home settings play a pivotal role in the education and support of mother-infant dyads. It is important to consider several findings of this study and the implications they have for nursing practice. First, maternal responses were lower than expected in this sample of low-income mother-infant dyads. Second, maternal responses were observed less often in bottle-feeding mothers. Third, 45% of the participants in the study reported introducing solid foods prior to T1 data collection. Lastly, almost 30% of the infants in this study had at least one weight-related risk factor (e.g., birth or T1 weight at or above the 85th percentile or RWG) for childhood obesity.

Maternal responses to infant hunger and satiety cues are foundational in promoting healthy eating habits and reducing childhood obesity. Currently, nationally funded programs are offered to support mothers who are breastfeeding their infants. For example, the Michigan Department of Community Health offers peer counseling for breastfeeding mothers. The Mother-to-Mother program is a partnership between WIC and Michigan State University Extension (Michigan Department of Community Health, 2011). In 1991, the United Nations Children's

Fund (formally United Nations International Children's Emergency Fund or UNICEF) and WHO encouraged reorganizing hospitals to support breastfeeding (Baby-Friendly Hospital Initiative, 2012). As of December 2011, 125 U.S hospitals have been designated as Baby-Friendly. The Baby Friendly Hospital Initiative requires a specific policy and procedure for breastfeeding that includes direction for maternal education and system changes such as "rooming in" and no pacifiers or artificial nipples.

Despite our best efforts to encourage breastfeeding, bottle-feeding, to some degree, is a common feeding method for a majority of U.S. infants between birth and 6 months of age. The number of women who initiated breastfeeding for infants born in 2005-2006 was reported at 77%, a 17% increase compared to only 60% initiation in infants who were born in 1993-1994 (McDowell et al., 2008). However, in the same report, breastfeeding initiation rates between 1999 and 2006 were only 57% for lower-income families compared to 74% in higher-income families. Although breastfeeding initiation rates are increasing, bottle-feeding continues to be a common feeding method, and has been cited as a potential risk factor for childhood obesity (Li et al., 2008; 2010; Owen et al., 2005; Rowland & Wallace, 2009; Tluczek et al., 2010). This study did not identify bottle-feeding as a predictor of high infant weight gain or RWG, but it did indicate that bottle-feeding affected maternal responses to infant feeding cues. Support to foster maternal responsiveness is needed for all mothers, even if they initiate breastfeeding in the hospital.

Nurses play a pivotal role in identification, development, and delivery of interventions to mothers to foster maternal responsiveness. Although breastfeeding initiation rates are above 75%, very few (14.1%) mothers continue to breastfed through 6 months. This study indicates that bottle-feeding mothers tend to have lower responsiveness scores when observed feeding their infants. Equal effort should be made to support and educate mothers who are bottle-feeding their infants. Early educational support aimed at recognizing and responding to infant hunger and satiety cues (natural self-regulation) while bottle-feeding are needed as early as birth. Nurses need to accept that a majority of mothers will transition to bottle-feeding, and nurses should develop an initiative to support maternal responsiveness, not just breastfeeding. Feeding support in general, not just breastfeeding support, should be available to all mothers during the first few months after birth.

The third implication for nursing practice is the introduction of solid foods. The AAP recommends the introduction of solid foods between 4 and 6 months to infants who are formula fed and at 6 months for exclusively breastfed infants (AAP, 2005; Kuo, Inkelas, Slusser, Maidenberg, & Halfon, 2011). This study showed that many participants had introduced solid foods to their infant, even with the study criterion that no solid food introduction had occurred.

The early introduction of solid foods, anything other than formula or breast milk, has been identified as a risk factor for childhood obesity. In a recent study of 847 children, among formula-fed infants, the introduction of solids before 4 months was associated with a 6-fold increase in the odds of obesity at 3 years of age (Huh, Rifas-Shiman, Taveras, Oken, & Gillman, 2011). Cross tabulation of bottle-feeding and solid-feeding indicated that almost half (46%) of the 94 mothers who bottle-fed reported introducing solids. This study reinforces the need to support the dissemination of AAP recommendations and investigate the effectiveness of interventions in reducing the number of infants who are exposed to solid food prior to 4 months of age.

Lastly, nurses are in a position to identify weight-related risk-factors in infancy that lead to childhood obesity. In this sample 38 (29%) infants had at least one weight-related risk-factor for childhood obesity. This implication is twofold. Anthropometric measures are often used as an overall assessment of infant health (Ball et al., 2012; CDC, 2011) and as part of a risk assessment for childhood obesity. Oftentimes anthropometric measures are collected by health care workers of various educational levels (Johnson et al., 2009), and it is important for nurses to validate the reliability of measurement skills and the documentation associated with infant health records to assure accurate data for monitoring of weight-related risk factors. Second, nurses need to advocate for policies that ensure consistent tracking of anthropometric measures in their places of employment.

Implications for Research

As outlined in chapter 3, the review of the literature identified gaps in knowledge related to the maternal-infant feeding interaction and infant weight gain. These gaps included identification of risk factors for RWG in infants aged birth to 6 months of age; comparison studies of maternal responsiveness across feeding methods and a clear definition and prevalence of RWG in infants from birth to 6 months of age.

Further investigation and research is needed to understand RWG prevalence in the infant population between birth and 6 months. Generally when the term RWG is used in the literature, it is weight-focused. There is a question of whether other anthropometric measures are also important to consider in combination with RWG as risk factors for childhood obesity.

Studies in the early ‘80s focused on infant growth redistribution, suggesting that long, lean infants would gain more weight than length, and short, heavier infants would gain more length than weight in the first three months of life (Davies, 1980; Fergusson, Horwood, & Shannon, 1980). In general, these studies suggested there was a regression to the mean in terms of birth weight and 3 month weight (Darlington & Wright, 2006; Fergusson et al., 1980). This study did not take into consideration infant recumbent length and this redistribution theory because in more recent studies researchers have indicated that *catch-up* weight, not length, can be problematic in terms of risk for childhood obesity in infants as young as 3 to 4 months of age (Gillman, 2010; Goodell & Wakefield, 2009). Tavaras et al. studied 559 children at birth, 6 months, and 3 years and found those children in the highest weight-for-length z-scores quartiles, at both birth and 6- months, had a predicted obesity prevalence of 40% at 36 months compared to 1% in those in the lowest quartile (2009, p. 1179). Once completed, the Healthy Babies data will contain longitudinal data from three points between birth and 12 months to investigate trends of RWG. Secondly, an investigation of recumbent length and RWG may be considered if a large enough sample of infants with RWG is found within the study. Other considerations to investigate the association between other anthropometric measures (e. g., recumbent length and head circumference) and RWG would be to conduct retrospective chart studies within larger pediatric offices where serial anthropometric measures would be accessible.

An important aspect of research is comparability. One of the gaps found in the literature was the lack of consistent a definition for RWG. Some studies use quartiles of weight gain to predict obesity (Baird et al., 2005; Dubois & Girard, 2006; Stettler et al, 2002). Darlington and Wright used the slowest and fastest 20% and the remaining 60% as average weight gain as a dependent variable predicated by infant temperament. It is essential that the findings of one study be comparable and translatable into practice. Thus a standard definition of RWG is needed.

Further study is recommended to explore RWG patterns in early infancy using several stable data collection points based on age. Although the sample was not large enough to split into two infant age categories and still have adequate power for analysis, there were interesting trends with RWG based on infant age.

Implications for Policy

Approximately 11% of infants under the age of 2 are over the 95th[th] percentile compared to the standard growth curve (Ogden, 2010), and as many as 25% of infants grow too rapidly during the first 2 years of life (Ekelund et al., 2006; Ong & Loos, 2006). Nurses play a role in identification of and counseling for mother-infant dyads where infants' growth place them at risk for obesity, especially in the first 6 months of life. In February of 2010, Michelle Obama began her "Let's Move" campaign against childhood obesity, with special interest at targeting children 2 years of age and under (Wojcicki & Heyman, 2010). The AAP recommends that anthropometric measures be completed and recorded at birth, 1 month, 2 months, 4 months, and 6 months (Krebs & Jacobson, 2003). Even though this study did not find specific antecedent predictors of RWG, the author believes strongly that a standardized, national infant anthropometric tracking system would enhance knowledge of growth patterns from birth to 6 months, allow comparisons, and serve as a measure for overall infant health-related quality of life in the population. Careful tracking of infant weight gain in comparison to the WHO growth chart during the first 6 months of life by health care providers is a key element in the overall risk assessment to reduce the prevalence of childhood obesity in our population.

The CDC growth chart has been available to practitioners since 1977 and until recently, the WHO also utilized the CDC growth chart as a standard for infant growth. In 2010, the CDC recognized the WHO chart as a growth standard and recommended its use by practitioners to compare growth of individual infants from birth to 24 months (Grummner-Strawn et al, 2010; Mei & Grummner-Strawn, 2011). Because this is a relatively new recommendation, it is not known how many hospitals, pediatric practitioners, or health departments utilize the WHO growth chart to track infant growth patterns. It is recommended that further research, using community-based, participatory research methods, be focused on developing a national infant anthropometric tracking system.

Diffusion of innovations is a theory proposed to describe how a new way of thinking or doing is communicated through a culture (Rogers, 2003). In the case of public health or health care, the diffusion of innovation framework is used to understand how evidence-based practice is created and shared with practitioners. The key elements of the diffusion theory are innovation, communication channels, time, and social system (Rogers, 2003). To implement a national infant anthropometric tracking system, the author proposes that nurse researchers use either individual interviews or focus groups to evaluate the characteristics of the decision making units or adopters (pediatric nurse practitioners, pediatricians, and family practice physicians), regarding knowledge, current practice, problems with infant weight tracking and perceptions of the WHO growth standard. These qualitative methods would serve two purposes: one, it exposes the practitioners to the idea (innovation), and two, it gives nurses the background for persuasive techniques to encourage adoption of a standardized growth-tracking method.

To adopt an innovation there must be a perception that there is some advantage over the existing way of practice. The relative advantage of the WHO growth chart is that the growth standard is based on a reference population that is healthy and adhering to the AAP, CDC, and WHO breastfeeding recommendations. Next, compatibility is the perception of the potential adopters whether the WHO growth chart is consistent with existing values and past experiences. Complexity is the perceived difficulty of the innovation by adopters.

Ideally, all infant growth tracking would be completed using WHO Anthro. Data from WHO Anthro could then be uploaded to a national data base where aggregate longitudinal data of infant growth during the first 6 months of life could be utilized for further research. WHO

Anthro is a free computer program downloadable to personal computers with a 60-page user manual. The complexity of the program is minimal, but does require training and relatively good computer skills. Because it is a free program, “trialability” of the new process would only require a time investment (office staff training). The last perceived characteristic of the innovation to be considered is *observability*. This characteristic is how the innovation is visible to others and easily measurable. WHO Anthro calculates WAP and WAZ along with a visual, plotted graph from the data entered.

Centralized infant growth tracking would provide a larger reference population to revise the CDC growth chart for infants aged birth to 6 months. The 2000 CDC growth reference chart and the WHO 2006 growth standard are based on cross-sectional data gathered in national survey data. Statistical curve fitting techniques were used to modify this cross-sectional data into longitudinal growth curves. Utilizing longitudinal data may provide a very different growth curve pattern. It is suggested that pilot studies begin small, in individual health care provider offices, or community settings such as health department well-child clinics, along with data on infant feeding practices to compare those growth patterns.

Conclusion

This study adds to the knowledge base in the exploration of antecedent predictors of RWG in a low-income infant population aged birth to 6 months. The primary purpose of the study was to determine to what extent maternal responses to infant feeding cues are associated with weight gain patterns in infants between birth and 6 months of age. The current study was guided by the Barnard PCI model. This model identified maternal and infant characteristics that influence the maternal-infant interaction. The proposed characteristics identified in the study model as influencing the maternal-child feeding interaction and relative infant weight gain and/or

RWG were analyzed. The proposed model for Aim 1 did not predict the outcome variable of relative weight gain but was found to be minimally significant for RWG (p = .048). This logistic regression model is reported with caution because of concerns with the reliability of the temperament subscales, of which the IBQ-NA scale was the only significant predictor within the logistic regression model predicting RWG. Only 15% of this population was identified as having RWG.

The proposed statistical model of maternal characteristics, guided by the PCI model, was shown to be significantly predictive of maternal responses to infant feeding cues, explaining 14% of the variability of the NCAFScc scores. Additionally, two infant characteristics (infant age and maternal perceived temperament of surgency) and one maternal characteristic (bottle feeding) were shown to be significant predictors. The wide variability of infant age may have been a factor; and it is recommended that further study, using the proposed study model, be conducted on a larger sample with more data collection points to identify weight gain patterns in infants' birth to 6 months.

This study contributes to the science of nursing by highlighting the need for education and supportive initiatives targeting bottle-feeding mothers. Lower maternal responsiveness has been identified as a risk factor for cognitive and physical development of infants and children (Ainsworth, 1969b; Faith et al., 2004; Hughes et al., 2005; Sacco et al., 2007). Further, this study suggests that any breastfeeding, even if the mother switched to bottle-feeding, increases average maternal responses to infant feeding cues. It will be important to explore this trend with the full sample of T1 data collected in the Health Babies Study. Early identification though infant weight tracking by nurses and health care providers and supportive maternal responsiveness education are both important assessment tools to reduce weight-related risk-factors associated with childhood obesity.

It will be important to disseminate the findings from this research study to pediatric nurses and other health care professionals. A second focus of dissemination is evaluation and standardization of growth patterns in infants from birth to 6 months of age. On average, this infant population gained weight at a slightly higher rate than expected. Future research with this sample should include longitudinal data, providing the opportunity to compare individual and sample aggregate infant growth curves to that of the WHO growth standard.

It is also of interest that the literature does not contain a consistent definition for RWG (Dennison et al., 2006; Ong, 2010) or failure-to-thrive (Olsen, 2006), and that practitioners and researchers are reluctant to identify infants as obese. Recent changes in the definitions for obesity only specify children older than age 2 (Ogden & Flegal, 2010), and the term, at-risk for overweight, not obese, is still used to describe an infant in the 85th percentile or higher on infant growth charts (McCormick et al., 2010). Second, other anthropometric infant measures may be important to consider in association with weight-related risk factors for childhood obesity. Further investigation of infant growth patterns and comparisons between the WHO growth standard and CDC growth charts are needed (Mei & Grummer-Strawn, 2011).

Nurses can be influential in the process of infant weight tracking and bottle-feeding education. Careful tracking of infant weight gain in comparison to the WHO growth standard during the first 6 month of life by health care providers is a key element in the overall risk assessment to reduce the prevalence of childhood obesity in our population. Nurses need to acknowledge that a majority of mothers will transition to bottle-feeding in the first few months of an infant’s life. Along with the breastfeeding initiative already in place, policies should be enacted that institute a tandem initiative to support mothers while they start or transition to bottle-feeding, so mothers remain responsive to their infants' feeding cues in the overall goal of reducing the risk of infant overweight.

APPENDICES

APPENDIX A

Study Instruments

Table A1

Edinburgh Postnatal Depression Scale 3-Item Scale (EPDS-3)

Question: In the past 7 days	HB response option	EPDS-3 scoring option
I have blamed myself unnecessarily when things went wrong.	1 = Yes, most of the time 2 = Yes, some of the time 3 = Not very often 4 = No, never	0 = No, never 1 = Not very often 2 = Yes, some of the time 3 = Yes, most of the time
I have been anxious or worried for no good reason.	1 = No, not at all 2 = Hardly ever 3 = Yes, sometimes 4 = Yes, very often	0 = No, not at all 1 = Hardly ever 2 = Yes, sometimes 3 = Yes, very often
I have felt scared or panicky for no very good reason.	1 = Yes, quite a lot 2 = Yes, sometimes 3 = No, not much 4 = No, not at all	0 = No, not at all 1 = No, not much 2 = Yes, sometimes 3 = Yes, quite a lot

Note. HB = *Healthy Babies through Infant Centered Feeding (USDA 2009-55215-05220*) study. EPDS-3 questions adapted from *Identifying postpartum depression: Are three questions as good as 10?*, by K. Kabir, J. Sheeder and L.S. Kelly, 2008, p. e702).

Table A2

NCAST-F/ PCI-F Maternal Contingent Response Subscale Questions (NCAFScc)

Subscale questions
6. Caregiver smiles, verbalizes, or makes eye contact with the child when the child is in open-face-gaze position.
7. Caregiver comments verbally on child's hunger cues prior to feeding.
8. Caregiver comments verbally on child's satiation cues before terminating feeding.
12. Caregiver allows pauses in feeding when the child shows potent disengagement cues or is in pause phase of the suck-pause sequence of sucking.
13. Caregiver slows the pace of feeding or pauses when child shows subtle disengagement cues.
14. Caregiver terminates the feeding when the child shows satiation cues or after other methods have proved unsuccessful.
17. Caregiver starts or stops feeding (in response to potent disengagement cue observed).
18. Caregiver changes the child's position (in response to potent disengagement cue observed).
19. Caregiver makes positive or sympathetic verbalization (in response to potent disengagement cue observed).
20. Caregiver changes voice volume to softer or higher pitch (in response to potent disengagement cue observed).
21. Caregiver makes soothing non-verbal efforts (in response to potent disengagement cue observed).
22. Caregiver diverts child's attention by playing games, introducing toy, or making faces (in response to potent disengagement cue observed).
38. Caregiver smiles, verbalizes, or touches child within five seconds of child smiling or vocalizing at caregiver.
48. Caregiver verbally responds to child's sound within five seconds after child has vocalized.
49. Caregiver verbally responds to child's movement within five seconds of the child's movement of arms, legs, hands, head, or trunk.

Note: NCAST-F/PCI-F = Nursing Child Assessment Satellite Training Feeding Scale/Parent-Child Interaction tool for feeding scale. Items are numbered from their original order in the *NCAST Caregiver Parent-Child Interaction Feeding Manual* (pp. 141-142), G. Sumner and A. Spietz, 1994, Seattle, WA: NCAST Publications NCAFS.

Table A3

Infant Behavior Questionnaire (IBQ)-Revised-Very Short Form: IBQ-Surgency Subscale(IBQ-S)

Subscale Questions
1. When being dressed or undressed during the last week, how often did the baby squirm and/or try to roll away?
2. When tossed around playfully how often did the baby laugh?
7. How often during the week did your baby move quickly toward new objects?
8. When put into the bath water, how often did the baby laugh?
13. When placed on his/her back, how often did the baby squirm and/or turn body?
14. During a peekaboo game, how often did the baby laugh?
15. How often does the infant look up from playing when the telephone rings?
20. When visiting a new place, how often did your baby get excited about exploring new surroundings?
21. How often during the last week did the baby smile or laugh when given a toy?
26. When hair was washed, how often did the baby vocalize?
27. How often did your baby notice the sound of an airplane passing overhead?
36. How often did your baby make talking sounds when riding in a car?
37. When placed in an infant seat or car seat, how often did the baby squirm and turn body?

Note. IBQ = Infant Behavior Questionnaire (Gartstein & Rothbart, 2003; Putnum et al., 2006).

Table A4

Infant Behavior Questionnaire (IBQ)-Revised-Very Short Form: IBQ-Negative Affect Subscale (IBQ-NA)

Subscale Questions
3. When tired, how often did your baby show distress?
4. When introduced to an unfamiliar adult, how often did the baby cling to a parent?
9. When it was time for bed or a nap and your baby did not want to go, how often did s/he whimper or sob?
10. After sleeping, how often did the baby cry if someone doesn't come within a few minutes?
16. How often did the baby seem angry (crying and fussing) when you left her/him in the crib?
17. How often during the last week did the baby startle at a sudden change in body position (e.g., when moved suddenly)?
22. At the end of an exciting day, how often did your baby become tearful?
23. How often during the last week did the baby protest being placed in a confining place (infant seat, play pen, car seat, etc.)?
28. When introduced to an unfamiliar adult, how often did the baby refuse to go to the unfamiliar person?
29. When you were busy with another activity, and your baby was not able to get your attention, how often did s/he cry?
32. When the baby wanted something, how often did s/he become upset when s/he could not get what s/he wanted?
33. When in the presence of several unfamiliar adults, how often did the baby cling to a parent?

Note. IBQ = Infant Behavior Questionnaire (Gartstein & Rothbart, 2003; Putnum et al., 2006).

Table A5

Infant Behavior Questionnaire (IBQ)-Revised-Very Short Form: IBQ-Effortful Control Subscale (IBQ-EC)

Subscale Questions
5. How often during the last week did the baby enjoy being read to?
6. How often during the last week did the baby play with one toy or object for 5-10 minutes?
11R. In the last week, while being fed in your lap, how often did the baby seem eager to get away as soon as the feeding was over?
12. When singing or talking to your baby, how often did s/he soothe immediately?
18. How often during the last week did the baby enjoy hearing the sound of words, as in nursery rhymes?
19. How often during the last week did the baby look at pictures in books and/or magazines for 5 minutes or longer at a time?
24. When being held, in the last week, did your baby seem to enjoy him/herself?
25. When showing the baby something to look at, how often did s/he soothe immediately?
30. How often during the last week did the baby enjoy gentle rhythmic activities, such as rocking or swaying?
31. How often during the last week did the baby stare at a mobile, crib bumper or picture for 5 minutes or longer?
34. When rocked or hugged, in the last week, did your baby seem to enjoy him/herself?
35. When patting or gently rubbing some part of the baby's body, how often did s/he soothe immediately?

Note. IBQ = Infant Behavior Questionnaire (Gartstein & Rothbart, 2003; Putnum et al., 2006).

APPENDIX B

NCAST Feeding Scale Coding Protocol from the Healthy Babies Parent Study

Materials needed:

1. NCAST caregiver/parent-child interaction feeding manual
2. Pink coding sheet
3. Log sheet
4. External hard drive with feeding interaction videos
5. Computer in quiet environment
    a. Interview rooms are available with a laptop, should you need one. The interview rooms need to be reserved.
    b. Head phones (optional)
6. Black or blue ink pen

Watch ~ 30 seconds of the video and then prepare the pink coding sheet:
On the front of the pink sheet (p. 1):
Place the participant dyad ID in the blank area after 1. Sensitivity to cues

Check the box for person observed as mother or father.
Check the box for type of feeding breast/bottle/solid
Length of feeding time is circled- based on the total video length
Please note if this total feeding time is different from what you observe
Setting is home
Specify others present at the feeding
Circle the child’s state

On the back of the pink sheet (p. 2):

Add date of observation in bottom left area (if available)
Secondly, write the word ‘coding’ after the date of observation entry and add the date you are coding the interaction.
Sign your name under recorder’s signature.

Watch the video as many times as necessary to code the video.

Place a small asterisk (*) within any box you are unable to determine a code; please provide an explanation near the box or in the clinical notes area (p. 2 on the pink sheet) as to the reason you are unable to determine a code for the item. Anecdotal notes/explanations may consist of the need for translation, video quality, timing, people or other miscellaneous issues that may interfere with your ability to code. Enter a brief comment on the log sheet regarding the inability to fully code this interaction and check the appropriate box. Please remember, any item with an asterisk (*) will be coded as “no” for the study, tracking of these issues is primarily to improve video quality.

Score NCAFS

Add totals for each subscale.
Enter subscale and contingency item totals.
Add the scores to obtain caregiver, infant and caregiver/infant totals.

Return completed NCAFS pink sheets to the Health Babies (HB) project manager by placing them in the yellow folder labeled “completed NCAST” in the same locked cabinet as the hard drive. Return the external hard drive and lock the cabinet.

The HB manager will add additional videos for coding on **both** the external hard drive and the log sheet. A log sheet will exist for each county. The HB manager will add (by hand) the participant ID.

The coders have been assigned 2 counties. To assure each video is coded twice each coder will initial the videos completed and note any areas where coding was unable to be determined along with comments and concerns. The two coders will them meet to compare coding scores and determine a final coding score, by consensus, for each video.

APPENDIX C

Scatterplot of Infant Age and Score on NCAFS Caregiver Contingency Subscale (NCAFScc)

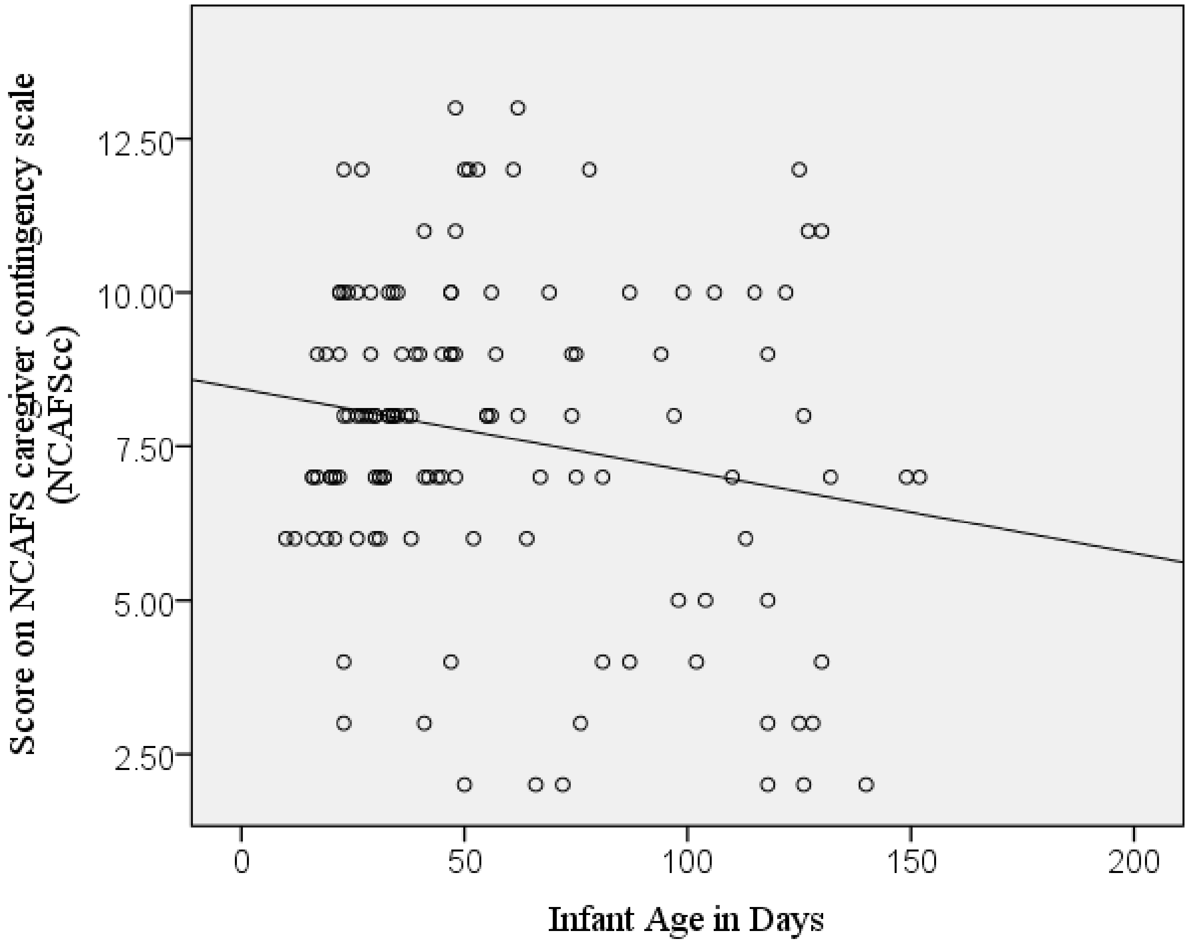

Figure C1. Scatterplot of infant age and score on Nursing Child Assessment Satellite Training Tool Caregiver Contingency Subscale.

APPENDIX D

Scatterplot of the IBQ-NA Subscale and Score on NCAFS Caregiver Contingency Subscale (NCAFScc)

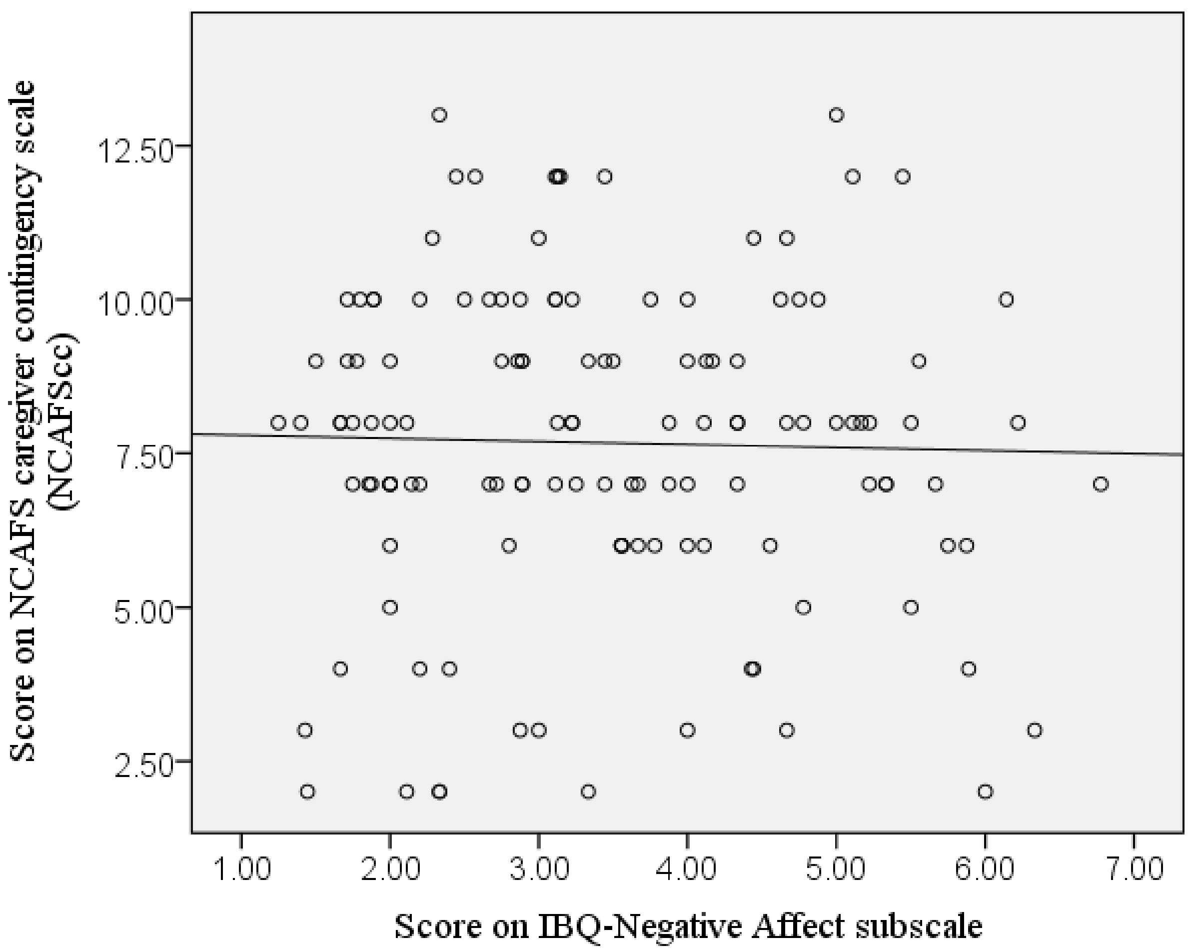

Figure D1. Scatterplot of negative affect infant temperament Measured by the Infant Behavior Questionnaire negative affect (IBQ-NA) subscale and score on Nursing Child Assessment Satellite Training Tool Caregiver Contingency (NCAFScc) Subscale

REFERENCES

REFERENCES

Aboud, F. E., Shafique, S., & Akhter, S. (2009). A responsive feeding intervention increases children's self-feeding and maternal responsiveness but not weight gain. *The Journal of Nutrition, 139*(9), 1738-1743. doi:10.3945/jn.109.104885.

Ainsworth, M. D. S. (1969a, March 3). *Maternal sensitivity scales*. Retrieved June 12, 2010, from http://www.psychology.sunysb.edu/attachment/measures/measures_index.html.

Ainsworth, M. D. S. (1969b). Object relations, dependency, and attachment: A theoretical review of the infant-mother relationship. *Child Development*, *40*(4), 969-1025.

Ainsworth, M. D. S., & Bowlby, J. (1991), An ethological approach to personality development. *American Psychologist, 46*, 331-341.

Amankwaa, L., & Pickler, R. (2007). Measuring maternal responsiveness. *The ABNF Journal: Official Journal of the Association of Black Nursing Faculty in Higher Education, Inc*, *18*(1), 4-15.

American Academy of Pediatrics [AAP] (2012). Ages & Stages, feeding and nutrition: Switching to solid foods. *Healthy Children* retrieved January 4, 2012 from http://www.healthychildren.org/English/ages-stages/baby/feeding-nutrition/Pages/default.aspx.

American Academy of Pediatrics [AAP] (2005). Breastfeeding and the use of human milk. *Pediatrics*, 115(2), 496-506. doi: 10.1542/peds.2004-2491.

Arenz, S., Rückerl, R., Koletzko, B., & von Kries, R. (2004). Breast-feeding and childhood obesity--a systematic review. *International Journal of Obesity and Related Metabolic Disorders: Journal of the International Association for the Study of Obesity*, *28*(10), 1247-1256. doi:10.1038/sj.ijo.0802758.

Baby-Friendly Hospital Initiative [BFHI] (2012). About BFHI. Retrieved January 7, 2012 from http://www.babyfriendlyusa.org/eng/01.html.

Baird, J., Fisher, D., Lucas, P., Kleijnen, J., Roberts, H., & Law, C. (2005). Being big or growing fast: systematic review of size and growth in infancy and later obesity. *BMJ*, *331*(7522), 929. doi:10.1136/bmj.38586.411273.E0.

Ball, J., Binder, R., & Cowen, R. (2012). *Principles of pediatric nursing: Caring for children* (5th ed.). New York: Pearson.

Barnard, K. (1974). *Child health assessment.* Bethesda Md.: U. S. Dept. of Health Education and Welfare Division of Nursing.

Barnard, K., Hammond, M., Booth, C., Bee, H., Mitchell, S., & Spieker (1989). Measurement and meaning of parent-child interaction. In F. Morrison, C. Lord, & D. P. Keating, [Ed] *Applied developmental psychology*. San Diego; New York; Berkeley: Academic Press.

Baumrind, D. (1966). Effects of authoritative parental control on child behavior. *Child Development*, *37*(4), 887-907.

Beck, C. T. (1995). The effects of postpartum depression on maternal-infant interaction: a meta-analysis. *Nursing Research*, *44*(5), 298-304.

Bentley, M E, Stallings, R. Y., Fukumoto, M., & Elder, J. A. (1991). Maternal feeding behavior and child acceptance of food during diarrhea, convalescence, and health in the central Sierra of Peru. *American Journal of Public Health*, *81*(1), 43-47.

Birch, L. L. (1998). Psychological influences on the childhood diet. *The Journal of Nutrition*, *128*(2 Suppl), 407S–410S.

Birch L. L., & Fisher J. A. (1995). Appetite and eating behavior in children. *Pediatric clinics of North America*, *42*(4), 931.

Britton, J. R., Britton, H. L., & Gronwaldt, V. (2006). Breastfeeding, sensitivity, and attachment. *Pediatrics*, *118*(5), e1436–1443. doi:10.1542/peds.2005-2916.

Brown, L. (2007). Heart rate variability in premature infants during feeding. *Biological Research for Nursing*, *8*(4), 283-293.

Brown, L.F., & Pridham, K. (2007). The effect of maternal depressive symptoms and early maternal feeding behavior on later infant feeding behavior. *Newborn & Infant Nursing Reviews*, *7*(1), 56-63.

Campbell, S. B. G. (1979). Mother-infant interaction as a function of maternal ratings of temperament. *Child Psychiatry & Human Development*, *10*(2), 67-76. doi:10.1007/BF01433498.

Campbell, S. B., Cohn, J. F., & Meyers, T. (1995). Depression in first-time mothers: Mother-infant interaction and depression chronicity. *Developmental Psychology*, *31*(3), 349-357. doi:10.1037/0012-1649.31.3.349.

Candelaria, M., Teti, D. M., & Black, M. M. (2011). Multi-risk infants: predicting attachment security from sociodemographic, psychosocial, and health risk among African-American preterm infants. *Journal of Child Psychology and Psychiatry, and Allied Disciplines 52(8)*, 870-7. doi:10.1111/j.1469-7610.2011.02361.x.

Carey, W. B. (1985). Temperament and increased weight gain in infants. *Journal of Developmental and Behavioral Pediatrics: JDBP*, *6*(3), 128-131.

Centers for Disease Control [CDC] (2011). *Overweight and obesity*. Retrieved from http://www.cdc.gov/obesity/index.html.

Centers for Disease Control [CDC] (2000). *2000 CDC Growth Charts for the United States: Methods and Development*. Retrieved from http://www.cdc.gov/nchs/data/series/sr_11/sr11_246.pdf.

Chatoor, I., Egan, J., Getson, P., Menvielle, E., & O'Donnell, R. (1988). Mother-infant interactions in infantile anorexia nervosa. *Journal of the American Academy of Child & Adolescent Psychiatry*, *27*(5), 535–540. doi:10.1097/00004583-198809000-00003.

Clark, R., Hyde, J. S., Essex, M. J., & Klein, M. H. (1997). Length of maternity leave and quality of mother-infant interactions. *Child Development*, *68*(2), 364-383.

Cohn, J. F., Campbell, S. B., Matias, R., & Hopkins, J. (1990). Face-to-face interactions of postpartum depressed and nondepressed mother-infant pairs at two months. *Developmental Psychology*, *26*(1), 15-23.

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

Cottrell, E.C., & Ozanne, S.E. (2008). Early life programming of obesity and metabolic disease. *Physiology & Behavior*, *94*(1), 17-28. doi:10.1016/j.physbeh.2007.11.017.

Cox, J. L., Holden, J. M., & Sagovsky, R. (1987). Detection of postnatal depression. Development of the 10-item Edinburgh Postnatal Depression Scale. *The British Journal of Psychiatry: The Journal of Mental Science*, *150*, 782-786.

Crockenberg, S. B. (1986). Are temperamental differences in babies associated with predictable differences in care giving? *New Directions for Child and Adolescent Development, 1986*(31), 53-73. doi:10.1002/cd.23219863105.

Darlington, A.S. E., & Wright, C. M. (2006). The influence of temperament on weight gain in early infancy. *Journal of Developmental and Behavioral Pediatrics: JDBP*, *27*(4), 329-335.

Davies, D. P. (1980). Size at birth and growth in the first year of life of babies who are overweight and underweight at birth. *The Proceedings of the Nutrition Society*, *39*(1), 25-33.

Dennis, C.L., & McQueen, K. (2009). The relationship between infant-feeding outcomes and postpartum depression: a qualitative systematic review. *Pediatrics*, *123*(4), e736-751. doi:10.1542/peds.2008-1629.

Denniston, C. (1994). Assessing normal and abnormal patterns of growth. *Primary Care*, *21*(4), 637-654.

Dennison, B. A., Edmunds, L. S., Stratton, H. H., & Pruzek, R. M. (2006). Rapid infant weight gain predicts childhood overweight. *Obesity*, *14*(3), 491-499. doi:10.1038/oby.2006.64.

de Onis, M. & Yip, R. (1996). The WHO growth chart: Historical considerations and current scientific issues. *Bibliotheca Nutritio et Dieta* (53) 74-89.

Derryberry, D., & Rothbart, M.K. (1988). Arousal, affect, and attention as components of temperament. *Journal of Personality and Social Psychology*, *55*(6), 958-966.

Dewey, K. G. (2001). Nutrition, growth, and complementary feeding of the breastfed infant. *Pediatric Clinics of North America*, *48*(1), 87-104.

Dewey, K. G., & Lonnerdal, B. (1986). Infant self-regulation of breast milk intake. *Acta Paediatrica*, *75*(6), 893-898. doi:10.1111/j.1651-2227.1986.tb10313.x.

DiSantis, K. I., Collins, B. N., Fisher, J. O., & Davey, A. (2011). Do infants fed directly from the breast have improved appetite regulation and slower growth during early childhood compared with infants fed from a bottle? *The International Journal of Behavioral Nutrition and Physical Activity*, *8*, 89. doi:10.1186/1479-5868-8-89.

DiSantis, K. I., Hodges, E. A., Johnson, S. L., & Fisher, J. O. (2011). The role of responsive feeding in overweight during infancy and toddlerhood: a systematic review. *International Journal of Obesity*, *35*(4), 480–492. doi:10.1038/ijo.2011.3.

Donovan, W. L., & Leavitt, L. A. (1978). Early cognitive development and its relation to maternal physiologic and behavioral responsiveness. *Child Development*, *49*(4), 1251-1254.

Donovan, W. L., Leavitt, L. A., & Walsh, R. O. (1998). Conflict and depression predict maternal sensitivity to infant cries. *Infant Behavior and Development*, *21*(3), 505-517. doi:10.1016/S0163-6383(98)90023-6.

Donovan, W., Taylor, N., & Leavitt, L. (2007). Maternal sensory sensitivity and response bias in detecting change in infant facial expressions: maternal self-efficacy and infant gender labeling. *Infant Behavior & Development*, *30*(3), 436-452. doi:10.1016/j.infbeh.2006.12.008.

Drake, E. E., Humenick, S. S., Amankwaa, L., Younger, J., & Roux, G. (2007). Predictors of maternal responsiveness. *Journal of Nursing Scholarship: An Official Publication of Sigma Theta Tau International Honor Society of Nursing / Sigma Theta Tau*, *39*(2), 119-125. doi:10.1111/j.1547-5069.2007.00156.x.

Dubois, L., & Girard, M. (2006). Early determinants of overweight at 4.5 years in a population-based longitudinal study. *International Journal of Obesity (2005)*, *30*(4), 610-617. doi:10.1038/sj.ijo.0803141.

Dubois, L., & Girard, M. (2003). Social inequalities in infant feeding during the first year of life. The longitudinal study of child development in Québec (LSCDQ 1998-2002). *Public Health Nutrition*, *6*(8), 773-783.

Else-Quest, N. M., Hyde, J. S., Goldsmith, H. H., & Van Hulle, C. A. (2006). Gender differences in temperament: A meta-analysis. *Psychological Bulletin*, *132*(1), 33-72. doi:10.1037/0033-2909.132.1.33.

Ekelund, U., Ong, K., Linné, Y., Neovius, M., Brage, S., Dunger, David B, Wareham, N. J., et al. (2006). Upward weight percentile crossing in infancy and early childhood independently predicts fat mass in young adults: the Stockholm Weight Development Study (SWEDES). *The American Journal of Clinical Nutrition*, *83*(2), 324-330.

Ekouevi, K., & Morgan, S. P. (1991). Note on the reliability and validity of mothers' retrospective reports of their children's birthweights. *Social Biology*, *38*(1-2), 140-145.

Eneli, I. U., Crum, P. A., & Tylka, T. L. (2008). The trust model: a different feeding paradigm for managing childhood obesity. *Obesity (Silver Spring, Md.)*, *16*(10), 2197-2204. doi:10.1038/oby.2008.378.

Faith, M. S., & Hittner, J. B. (2010). Infant temperament and eating style predict change in standardized weight status and obesity risk at 6 years of age. *International Journal of Obesity (2005)*, *34*(10), 1515-1523. doi:10.1038/ijo.2010.156.

Faith, M. S., Scanlon, K. S., Birch, Leann L., Francis, L. A., & Sherry, B. (2004). Parent-child feeding strategies and their relationships to child eating and weight status. *Obesity*, 12(11), 1711-1722.

Feldman, J. F., Brody, N., & Miller, S. (1980). Sex differences in non-elicited neonatal behaviors. *Merrill-Palmer Quarterly*, 26(1), 63-73.

Fergusson, D.M., Horwood, L.J, & Shannon, F.T. (1980) Length and weight gain in the first three months of life. *Human Biology*, 52(2), 169-180.

Field, A. P. (2005). *Discovering statistics using SPSS* (2nd ed.). Thousand Oaks, CA: Sage.

Finkelstein, E. A., Trogdon, J. G., Cohen, J. W., & Dietz, W. (2009). Annual medical spending attributable to obesity: Payer and service-specific estimates. *Health Affairs*, *28*(5), w822 - w831. doi:10.1377/hlthaff.28.5.w822.

Flegal, K. M., Carroll, M. D., Ogden, C. L., & Curtin, L. R. (2010). Prevalence and trends in obesity among US Adults, 1999-2008. *JAMA: The Journal of the American Medical Association*, *303*(3), 235 -241. doi:10.1001/jama.2009.2014.

Foss, L., Hirose, T., & Barnard, K. (1999). Relationship of three types of parent-child interaction in depressed and non-depressed mothers and their children's mental development at 13 months. *Nursing & Health Sciences*, *1*(4), 211-219.

Gartstein, M. A., & Rothbart, M. K. (2003). Studying infant temperament via the revised infant behavior questionnaire. *Infant Behavior and Development*, *26*(1), 64-86. doi:10.1016/S0163-6383(02)00169-8.

Gatti, L. (2008). Maternal perceptions of insufficient milk supply in breastfeeding. *Journal of Nursing Scholarship: An Official Publication of Sigma Theta Tau International Honor Society of Nursing / Sigma Theta Tau*, *40*(4), 355-363. doi:10.1111/j.1547-5069.2008.00234.x.

Gillman, M. W. (2010). Early infancy as a critical period for development of obesity and related conditions. *Nestlé Nutrition Workshop Series. Paediatric Programme*, *65*, 13-20; discussion 20-24. doi:10.1159/000281141.

Goldsmith, H. H., Buss, A. H., Plomin, R., Rothbart, M. K., Thomas, A., Chess, S., Hinde, R. A., et al. (1987). Roundtable: what is temperament? Four approaches. *Child Development*, *58*(2), 505-529.

Goodell, L. S., Wakefield, D. B., & Ferris, A. M. (2009). Rapid weight gain during the first year of life predicts obesity in 2-3 year olds from a low-income, minority population. *Journal of Community Health*, *34*(5), 370-375. doi:10.1007/s10900-009-9164-6.

Gross, R. S., Fierman, A. H., Mendelsohn, A. L., Chiasson, M. A., Rosenberg, T. J., Scheinmann, R., & Messito, M. J. (2010). Maternal perceptions of infant hunger, satiety, and pressuring feeding styles in an urban Latina WIC population. *Academic Pediatrics*, *10*(1), 29-35. doi:10.1016/j.acap.2009.08.001.

Grummer-Strawn, L.M., Reinold, C., & Krebs, N. F. (2010). Use of World Health Organization and CDC growth charts for children aged 0-59 months in the United States. *MMWR. Recommendations and Reports: Morbidity and Mortality Weekly Report. Recommendations and Reports / Centers for Disease Control*, *59*(RR-9), 1-15.

Helbig, A.L., Putnam, S.P., Gartstein, M.A., & Rothbart, M.K. (2009, April) *Development and assessment of short and very short forms of the infant behavior questionnaire-revised*. Presentation at the biannual convention of the Society for Research in Child Development, Denver, CO.

Hodges, E. A., Houck, G. M., & Kindermann, T. (2007). Reliability of the Nursing Child Assessment Feeding Scale during toddlerhood. *Issues in Comprehensive Pediatric Nursing*, *30*(3), 109-130. doi:10.1080/01460860701525204.

Horodynski, M., Olson, B., Arndt, M. J., Brophy-Herb, H., Shirer, K., & Shemanski, R. (2007). Low-income mothers' decisions regarding when and why to introduce solid foods to their infants: influencing factors. *Journal of Community Health Nursing*, *24*(2), 101-118. doi:10.1080/07370010701316247.

Horodynski, M.A., Olson, B., Baker, S., Brophy-Herb, H., Auld, G., Van Egeren, L., Lindau, J., & Singleterry, L. (2011). Healthy babies through infant-centered feeding protocol: and intervention targeting early childhood obesity in vulnerable populations. *BioMed Central Public Health*, 11:868. Retrieved at http://www.biomedcentral.com/1471-2458/11/868.

Horodynski, M., Olson, B., Brophy-Herb, H., Silk, K., & Shirer, K. (2008). The Infant Feeding Series (TIFS) curriculum. *Journal of Nutrition Education and Behavior*, *40*(3), 187–188. doi:10.1016/j.jneb.2007.03.004.

Hosseini, F., Borzouei, B., & Vahabian, M. (2011). Failure to thrive severity determination by new design curves in standard growth charts. *Acta Medica Iranica*, *49*(12), 795-800.

Hughes, S. O., Power, T. G., Orlet Fisher, J., Mueller, S., & Nicklas, T. A. (2005). Revisiting a neglected construct: parenting styles in a child-feeding context. *Appetite*, *44*(1), 83-92. doi:10.1016/j.appet.2004.08.007.

Huh, S. Y., Rifas-Shiman, S. L., Taveras, E. M., Oken, E., & Gillman, M. W. (2011). Timing of solid food introduction and risk of obesity in preschool-aged children. *Pediatrics*, *127*(3), e544-551. doi:10.1542/peds.2010-0740.

Hurley, K. M., Black, M. M., Papas, M. A., Caulfield, L. E., & Caufield, L. E. (2008). Maternal symptoms of stress, depression, and anxiety are related to nonresponsive feeding styles in a statewide sample of WIC participants. *The Journal of Nutrition*, *138*(4), 799-805.

Hurley, K. M., Cross, M. B., & Hughes, S. O. (2011). A Systematic Review of Responsive Feeding and Child Obesity in High-Income Countries. *The Journal of Nutrition*, *141*(3), 495–501. doi:10.3945/jn.110.130047.

Israel, B. A., Schulz, A. J., Parker, E. A., & Becker, A. B. (1998). Review of community-based research: assessing partnership approaches to improve public health. *Annual Review of Public Health*, *19*, 173-202. doi:10.1146/annurev.publhealth.19.1.173

Iverson, J. M. (2010). Multimodality in infancy: vocal-motor and speech-gesture coordinations in typical and atypical development. *Enfance; psychologie, pedagogie, neuropsychiatrie, sociologie*, *2010*(3), 257–274. doi:10.4074/S0013754510003046

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

Johnson, W., Cameron, N., Dickson, P., Emsley, S., Raynor, P., Seymour, C., & Wright, J. (2009). The reliability of routine anthropometric data collected by health workers: A cross-sectional study. *International Journal of Nursing Studies. Vol 46(3)*, *46*, 310–316.

Kabir, K., Sheeder, J., & Kelly, L. S. (2008). Identifying postpartum depression: Are 3 questions as good as 10? *Pediatrics*, 122(3), e696-702. doi:10.1542/peds.2007-1759.

Kavanagh, K. F., Habibi, M., Anderson, K., & Spence, M. (2010). Caregiver- vs infant-oriented feeding: A model of infant-feeding strategies among special supplemental nutrition program for women, infants, and children participants in rural East Tennessee. *Journal of the American Dietetic Association, 110*(10), 1485-1491. doi:10.1016/j.jada.2010.07.009.

Koplan, J. (2007). *Progress in preventing childhood obesity : how do we measure up?* Washington D.C.: National Academies Press.

Krebs, N. F., & Jacobson, M. S. (2003). Prevention of pediatric overweight and obesity. *Pediatrics*, *112*(2), 424-430.

Kröller, K., & Warschburger, P. (2009). Maternal feeding strategies and child's food intake: considering weight and demographic influences using structural equation modeling. *International Journal of Behavioral Nutrition and Physical Activity*, 6, 78-78. doi:10.1186/1479-5868-6-78.

Kuczmarski, R.J., Ogden, C. L., Grummer-Strawn, L. M., Flegal, K. M., Guo, S. S., Wei, R., Mei, Z., et al. (2000). CDC growth charts: United States. *Advance Data*, (314), 1-27.

Kuczmarski, R.J., Ogden, C.L., Guo, S.S., Grummer-Strawn, L.M., Flegal, K.M., Mei, Z., Wei, R., et al. (2002). 2000 CDC growth charts for the United States: methods and development. *Vital and Health Statistics. Series 11, Data from the National Health Survey*, (246), 1-190.

Kuo, A. A., Inkelas, M., Slusser, W. M., Maidenberg, M., & Halfon, N. (2011). Introduction of solid food to young infants. *Maternal and Child Health Journal*, *15*(8), 1185-1194. doi:10.1007/s10995-010-0669-5.

Lamb, M. M., Dabelea, D., Yin, X., Ogden, L. G., Klingensmith, G. J., Rewers, M., & Norris, J. M. (2010). Early-life predictors of higher body mass index in healthy children. *Annals of Nutrition & Metabolism, 56*(1), 16-22. doi:10.1159/000261899.

Lamb, M., & Easterbrooks, M.A. (1981). *Infant social cognition: empirical and theoretical considerations*. Hillsdale N.J.: L. Erlbaum Associates.

Lavelli, M., & Poli, M. (1998). Early mother-infant interaction during breast- and bottle-feeding. *Infant Behavior and Development*, *21*(4), 667-683. doi:10.1016/S0163-6383(98)90037-6.

Li, R., Fein, S. B., & Grummer-Strawn, L. M. (2008). Association of breastfeeding intensity and bottle-emptying behaviors at early infancy with infants' risk for excess weight at late infancy. *Pediatrics, 122 Suppl 2*, S77-84. doi:10.1542/peds.2008-1315j.

Li, R., Fein, S. B., & Grummer-Strawn, L. M. (2010). Do infants fed from bottles lack self-regulation of milk intake compared with directly breastfed infants? *Pediatrics*, *125*(6), e1386-1393. doi:10.1542/peds.2009-2549.

Lindsay, A. C., Machado, M. T., Sussner, K. M., Hardwick, C. K., & Peterson, K. E. (2008). Infant-feeding practices and beliefs about complementary feeding among low-income Brazilian mothers: a qualitative study. *Food and Nutrition Bulletin*, *29*(1), 15–24.

Lutz, K. F., Anderson, L. S., Pridham, K. A., Riesch, S. K., & Becker, P. T. (2009). Furthering the understanding of parent-child relationships: a nursing scholarship review series. Part 1: Introduction. *Journal for Specialists in Pediatric Nursing: JSPN*, *14*(4), 256-261. doi:10.1111/j.1744-6155.2009.00206.x.

Malatesta, C. Z., & Haviland, J. M. (1982). Learning display rules: the socialization of emotion expression in infancy. *Child Development*, *53*(4), 991-1003.

McCormick, D. P., Sarpong, K., Jordan, L., Ray, L. A., & Jain, S. (2010). Infant obesity: are we ready to make this diagnosis? *The Journal of Pediatrics*, *157*(1), 15-19. doi:10.1016/j.jpeds.2010.01.028.

McDowell, M.M., Wang, C., & Kennedy-Stephenson, J. (2008, April). NCAS data brief: Breastfeeding in the United States: Findings from the National Health and Nutrition Examination Surveys, 1999-2006. *NCAS Data Brief No. 5.* Retrieved from http://www.cdc.gov/nchs/data/databriefs/db05.pdf.

Mei, Z., & Grummer-Strawn, L.M. (2011). Comparison of changes in growth percentiles of US children on CDC 2000 growth charts with corresponding changes on WHO 2006 growth charts. *Clinical Pediatrics*, 50(5):402-7. doi:10.1177/0009922810392774.

Mei, Z., Ogden, C.L., Flegal, K.M., & Grummer-Strawn, L.M. (2008). Comparison of the prevalence of shortness, underweight, and overweight among US children aged 0 to 59 months by using the CDC 2000 and the WHO 2006 growth charts. *The Journal of Pediatrics*, *153*(5), 622-628. doi:10.1016/j.jpeds.2008.05.048.

Mennella, J. A., Ventura, A. K., & Beauchamp, G. K. (2011). Differential growth patterns among healthy infants fed protein hydrolysate or cow-milk formulas. *Pediatrics*, *127*(1), 110-118. doi:10.1542/peds.2010-1675.

Mentro, A. M., Steward, D. K., & Garvin, B. J. (2002). Infant feeding responsiveness: a conceptual analysis. *Journal of Advanced Nursing*, *37*(2), 208-216.

Meredith, H.V. (1949). A ‘physical growth record’ for elementary and high schools. *American Journal of Public Health*, 39; 878-885.

Merriam, S. B. & Caffarella, R. (1999). *Learning in adulthood: A comprehensive guide* (2nd ed.). San Francisco: Jossey-Bass.

Merriam-Webster Inc. (2003). *Merriam-Webster's collegiate dictionary*. (11th ed.). Springfield MA: Merriam-Webster Inc.

Michels, K. B., Willett, W. C., Graubard, B. I., Vaidya, R. L., Cantwell, M. M., Sansbury, L. B., & Forman, M. R. (2007). A longitudinal study of infant feeding and obesity throughout life course. *International Journal of Obesity (2005)*, *31*(7), 1078-1085. doi:10.1038/sj.ijo.0803622.

Monasta, L., Batty, G. D., Cattaneo, A., Lutje, V., Ronfani, L., Van Lenthe, F. J., & Brug, J. (2010). Early-life determinants of overweight and obesity: a review of systematic reviews. *Obesity Reviews*, *11*(10), 695-708. doi:10.1111/j.1467-789X.2010.00735.x.

Monteiro, P. O. A., & Victora, C. G. (2005). Rapid growth in infancy and childhood and obesity in later life--a systematic review. *Obesity Reviews: An Official Journal of the International Association for the Study of Obesity*, *6*(2), 143-154. doi:10.1111/j.1467-789X.2005.00183.x.

Montoya, C., & Lobo, M. L. (2011). Childhood obesity: a Wilsonian concept analysis. *Journal of Pediatric Nursing*, *26*(5), 465-473. doi:10.1016/j.pedn.2011.04.005.

Moorcroft, K. E., Marshall, J. L., & McCormick, F. M. (2011). Association between timing of introducing solid foods and obesity in infancy and childhood: a systematic review. *Maternal & Child Nutrition*, *7*(1), 3-26. doi:10.1111/j.1740-8709.2010.00284.x.

Mogan, J. (1986). Parental weight and its relation to infant feeding patterns and infant obesity. *International Journal of Nursing Studies*, *23*(3), 255–264. doi:10.1016/0020-7489(86)90023-4.

Mumme, D. L., Fernald, A., & Herrera, C. (1996). Infants' responses to facial and vocal emotional signals in a social referencing paradigm. *Child Development*, *67*(6), 3219-3237.

Nash, A., Secker, D., Corey, M., Dunn, M., & O'Connor, D. L. (2008). Field testing of the 2006 World Health Organization growth charts from birth to 2 years: assessment of hospital undernutrition and overnutrition rates and the usefulness of BMI. *JPEN. Journal of Parenteral and Enteral Nutrition*, *32*(2), 145-153. doi:10.1177/0148607108314386.

National Center for Education Statistics (2010). *Trends in high school dropout and completion rates in the United States: 1972-2008*. Compendium Report retrieved from http://nces.ed.gov/pubs2011/2011012.pdf.

NCAST Programs (2011). *Promoting nurturing environments for young children*. Retrieved June 21, 2011 from http://www.ncast.org/index.html.

Niegel, S., Ystrom, E., & Vollrath, M. E. (2007). Is difficult temperament related to overweight and rapid early weight gain in infants? A prospective cohort study. *Journal of*

Developmental and Behavioral Pediatrics: JDBP, *28*(6), 462-466. doi:10.1097/DBP.0b013e31811431e8.

O'Connor, T. G., Heron, J., & Glover, V. (2002). Antenatal anxiety predicts child behavioral/emotional problems independently of postnatal depression. *Journal of the American Academy of Child and Adolescent Psychiatry*, *41*(12), 1470-1477. doi:10.1097/00004583-200212000-00019.

Ogden, C. L. (2004). Defining overweight in children using growth charts. *Maryland Medicine: MM: A Publication of MEDCHI, the Maryland State Medical Society*, *5*(3), 19-21.

Ogden, C. L., & Flegal, K. M. (2010). Changes in terminology for childhood overweight and obesity. *National Health Statistics Reports*, (25), 1-5.

Ogden, C. L., Carroll, M. D., Curtin, L. R., Lamb, M. M., & Flegal, K. M. (2010). Prevalence of high body mass index in US children and adolescents, 2007-2008. *JAMA: The Journal of the American Medical Association*, *303*(3), 242-249. doi:10.1001/jama.2009.2012.

Ogden, C. L., Carroll, M. D., Curtin, L. R., McDowell, M. A., Tabak, C. J., & Flegal, K. M. (2006). Prevalence of overweight and obesity in the United States, 1999-2004. *JAMA: The Journal of the American Medical Association*, *295*(13), 1549-1555. doi:10.1001/jama.295.13.1549.

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

Ogden, C. L., Wei, R., Curtin, L. R., & Flegal, K. M. (2010). The 2000 Centers for Disease Control and Prevention growth charts: several insights after 8 years. *Nestlé Nutrition Workshop Series. Paediatric Programme*, *65*, 181-193; discussion 193-195. doi:10.1159/000281163.

Olafsen, K. S., Rønning, J. A., Handegård, B. H., Ulvund, S. E., Dahl, L. B., & Kaaresen, P. I. (2012). Regulatory competence and social communication in term and preterm infants at 12 months corrected age. Results from a randomized controlled trial. *Infant Behavior and Development*, *35*(1), 140–149. doi:10.1016/j.infbeh.2011.08.001.

Olsen, E. M. (2006). Failure to thrive: still a problem of definition. *Clinical Pediatrics*, *45*(1), 1-6.

Olsen, E. M., Skovgaard, A. M., Weile, B., Petersen, J., & Jørgensen, T. (2010). Risk factors for weight faltering in infancy according to age at onset. *Paediatric and Perinatal Epidemiology*, *24*(4), 370-382. doi:10.1111/j.1365-3016.2010.01118.x.

Olson, B. H., Horodynski, M. A., Brophy-Herb, H., & Iwanski, K. C. (2010). Health professionals' perspectives on the infant feeding practices of low income mothers. *Maternal and Child Health Journal*, *14*(1), 75-85. doi:10.1007/s10995-008-0425-2.

Ong, K. K. (2010). Early determinants of obesity. *Endocrine Development*, *19*, 53-61. doi:10.1159/000316897.

Ong, K K, Ahmed, M. L., Emmett, P. M., Preece, M. A., & Dunger, D B. (2000). Association between postnatal catch-up growth and obesity in childhood: prospective cohort study. *BMJ (Clinical Research Ed.)*, *320*(7240), 967-971.

Ong, K. K, & Loos, R. J. F. (2006). Rapid infancy weight gain and subsequent obesity: systematic reviews and hopeful suggestions. *Acta Paediatrica (Oslo, Norway: 1992)*, *95*(8), 904-908. doi:10.1080/08035250600719754.

Osofsky, J. D., & O'Connell, E. J. (1977). Patterning of Newborn Behavior in an Urban Population. Retrieved from http://www.eric.ed.gov/ERICWebPortal/detail?accno=EJ164723.

Owen, C. G., Martin, R. M., Whincup, P. H., Smith, G. D., & Cook, D. G. (2005). Effect of infant feeding on the risk of obesity across the life course: a quantitative review of published evidence. *Pediatrics*, *115*(5), 1367-1377. doi:10.1542/peds.2004-1176.

Oyama, M., Nakamura, K., Tsuchiya, Y., & Yamamoto, M. (2009). Unhealthy maternal lifestyle leads to rapid infant weight gain: prevention of future chronic diseases. *The Tohoku Journal of Experimental Medicine*, *217*(1), 67-72.

Parade, S. H., & Leerkes, E. M. (2008). The reliability and validity of the Infant Behavior Questionnaire-Revised. *Infant Behavior & Development*, *31*(4), 637-646. doi:10.1016/j.infbeh.2008.07.009.

Paul, I. M., Bartok, C. J., Downs, D. S., Stifter, C. A., Ventura, A. K., & Birch, L.L. (2009). Opportunities for the primary prevention of obesity during infancy. *Advances in Pediatrics*, *56*, 107-133. doi:10.1016/j.yapd.2009.08.012.

Pederson, D. R., Moran, G., Sitko, C., Campbell, K., Ghesquire, K., & Acton, H. (1990). Maternal sensitivity and the security of infant-mother attachment: a Q-sort study. *Child Development*, *61*(6), 1974-1983.

Pinyerd, B. J. (1992). Assessment of infant growth. *Journal of Pediatric Health Car,e 6*(5 Pt 2), 302-308.

Pridham, K. F., Schroeder, M., Brown, R, & Clark, R. (2001). The relationship of a mother's working model of feeding to her feeding behaviour. *Journal of Advanced Nursing*, *35*(5), 741-750.

Pridham, K. A., Lutz, K. F., Anderson, L. S., Riesch, S. K., & Becker, P. T. (2010). Furthering the understanding of parent-child relationships: A nursing scholarship review series. Part 3: Interaction and the parent–child relationship—Assessment and intervention studies. *Journal for Specialists in Pediatric Nursing. Vol 15(1)*, *15*(2010), 33-61.

Pridham, K. Steward, D., Thoyre, S., Brown, R., & Brown, L. (2007). Feeding skill performance in premature infants during the first year. *Early Human Development*, *83*(5), 293-305. doi:10.1016/j.earlhumdev.2006.06.004.

Puckett, B., Grover, V. K., Holt, T., & Sankaran, K. (2008). Cue-based feeding for preterm infants: a prospective trial. *American Journal of Perinatology*, *25*(10), 623-628. doi:10.1055/s-0028-1090583.

Putnam, S. P., Gartstein, M. A., & Rothbart, M. K. (2006). Measurement of fine-grained aspects of toddler temperament: The Early Childhood Behavior Questionnaire. *Infant Behavior and Development, 29* (3), 386-401.

Raynor, P., & Rudolf, M. (2000). Anthropometric indices of failure to thrive. *Archives of Disease in Childhood*, *82*(5), 364-365. doi:10.1136/adc.82.5.364.

Rogers, E. (1983). *Diffusion of innovations* (3rd ed.). New York: Collier Macmillan.

Ross, L. E., Gilbert-Evans, S. E., Sellers, E. M., & Romach, M. K. (2003). Measurement issues in postpartum depression part 1: anxiety as a feature of postpartum depression. *Archives of Women's Mental Health*, *6*(1), 51-57. doi:10.1007/s00737-002-0155-1.

Rothbart, M. K. (1981). Measurement of Temperament in Infancy. *Child Development*, *52*(2), 569-578. doi:10.2307/1129176.

Rothbart, M. K. (1982). The concept of difficult temperament: A critical analysis of Thomas, Chess & Korn. *Merrill-Palmer Quarterly*, *28*, 35-40.

Rothbart Temperament Lab (2011). *Mary Rothbart Temperament Questionnaires*. Retrieved April 15, 2011 from http://www.bowdoin.edu/~sputnam/rothbart-temperament-questionnaires.

Rowland, K., & Wallace, R. (2009). Clinical inquiries: Which factors increase the risk of an infant becoming an overweight child? *The Journal of Family Practice*, *58*(7), 383-384.

Sacco, L. M., Bentley, M.E, Carby-Shields, K., Borja, J. B., & Goldman, B.D. (2007). Assessment of infant feeding styles among low-income African-American mothers: comparing reported and observed behaviors. *Appetite*, *49*(1), 131-140. doi:10.1016/j.appet.2007.01.004.

Seidman, D. S., Slater, P. E., Ever-Hadani, P., & Gale, R. (1987). Accuracy of mothers' recall of birthweight and gestational age. *British Journal of Obstetrics and Gynaecology*, *94*(8), 731-735.

Seifer, R., Schiller, M., Sameroff, A. J., Resnick, S., & Riordan, K. (1996). Attachment, maternal sensitivity, and infant temperament during the first year of life. *Developmental Psychology*, *32*(1), 12-25. doi:10.1037/0012-1649.32.1.12.

Schiffman, R. F., Omar, M. A., & McKelvey, L. M. (2003). Mother-infant interaction in low-income families. *MCN. The American Journal of Maternal Child Nursing*, *28*(4), 246-251.

Shin, H., Park, Y.-J., Ryu, H., & Seomun, G.-A. (2008). Maternal sensitivity: a concept analysis. *Journal of Advanced Nursing*, *64*(3), 304-314. doi:10.1111/j.1365-2648.2008.04814.x.

Singhal, A., Kennedy, K., Lanigan, J., Fewtrell, M., Cole, T. J., Stephenson, T., Elias-Jones, A., et al. (2010). Nutrition in infancy and long-term risk of obesity: evidence from 2 randomized controlled trials. *The American Journal of Clinical Nutrition*, *92*(5), 1133 – 1144. doi:10.3945/ajcn.2010.29302.

Sleddens, E. F. C., Gerards, S. M. P. L., Thijs, C., de Vries, N. K., & Kremers, S. P. J. (2011). General parenting, childhood overweight and obesity-inducing behaviors: a review. *International Journal of Pediatric Obesity: IJPO: An Official Journal of the International Association for the Study of Obesity*, *6*(2-2), e12–27. doi:10.3109/17477166.2011.566339.

Slining, M., Adair, L. S., Goldman, B.D., Borja, J. B., & Bentley, M. (2010). Infant overweight is associated with delayed motor development. *The Journal of Pediatrics*, 157(1), 20-25. doi:10.1016/j.jpeds.2009.12.054.

Small, M. (1998). *Our babies, ourselves: How biology and culture shape the way we parent* (1st ed.). New York: Anchor Books.

Soper, D. (2011). *Statistical calculator index.* Retrieved from http://danielsoper.com/statcalc3/calc.aspx?id=1.

Stein, A., Arteche, A., Lehtonen, A., Craske, M., Harvey, A., Counsell, N., & Murray, L. (2010). Interpretation of infant facial expression in the context of maternal postnatal depression. *Infant Behavior & Development*, *33*(3), 273-278. doi:10.1016/j.infbeh.2010.03.002.

Stettler, N., Kumanyika, S. K., Katz, S. H., Zemel, B. S., & Stallings, V. A. (2003). Rapid weight gain during infancy and obesity in young adulthood in a cohort of African Americans. *The American Journal of Clinical Nutrition*, *77*(6), 1374 -1378.

Stettler, N., Zemel, B. S., Kumanyika, S., & Stallings, V. A. (2002). Infant weight gain and childhood overweight status in a multicenter, cohort study. *Pediatrics*, *109*(2), 194-199.

Stiles, A. S. (2010). Case study of an intervention to enhance maternal sensitivity in adolescent mothers. *Journal of Obstetric, Gynecologic, and Neonatal Nursing: JOGNN / NAACOG, 39*(6), 723-733. doi:10.1111/j.1552-6909.2010.01183.x.

Stommel, M. & Wills, C. (2004). *Clinical research: Concepts and principles for advanced practice nurses*. Philadelphia: Lippincott Williams & Wilkins.

Sumner, G., & Spietz, A. [Ed] (1994). *NCAST caregiver parent-child interaction feeding manual*. Seattle WA: NCAST Publications.

Tabachnick, B., & Fidell, L. (2008). *Using multivariate statistics*. Boston: Pearson/Allyn & Bacon.

Taveras, E. M., Rifas-Shiman, S. L., Belfort, M. B., Kleinman, K. P., Oken, E., & Gillman, M. W. (2009). Weight status in the first 6 months of life and obesity at 3 years of age. *Pediatrics, 123*(4), 1177-1183. doi:10.1542/peds.2008-1149.

Tharner, A., Luijk, M. P. C. M., Raat, H., Ijzendoorn, M. H., Bakermans-Kranenburg, M. J., Moll, H. A., Jaddoe, V. W. V., et al. (2012). Breastfeeding and its relation to maternal sensitivity and infant attachment. *Journal of Developmental and Behavioral Pediatrics: [Epub ahead of print]*, doi:10.1097/DBP.0b013e318257fac3.

Thomas, A., Chess, S., & Birch, H.G. (1968). *Temperament and behavior disorders in children*. New York: New York University Press.

Thompson, A. L., Mendez, M. A., Borja, J. B., Adair, L. S., Zimmer, C. R., & Bentley, M.E. (2009). Development and validation of the Infant Feeding Style Questionnaire. *Appetite, 53*(2), 210-221. doi:10.1016/j.appet.2009.06.010.

Tluczek, A., Clark, R. McKechnie, A. C., Orland, K. M., & Brown, R. L. (2010). Task-oriented and bottle feeding adversely affect the quality of mother-infant interactions after abnormal newborn screens. *Journal of Developmental and Behavioral Pediatrics: JDBP*, *31*(5), 414-426. doi:10.1097/DBP.0b013e3181dd5049.

Tronick, E., & Reck, C. (2009). Infants of depressed mothers. *Harvard Review of Psychiatry, 17*(2), 147-156. doi:10.1080/10673220902899714.

U.S. Department of Health and Human Resources [HRSA] (2011). Child health USA 2008-2009. Retrieved June 22, 2011 from http://mchb.hrsa.gov/chusa08/popchar/pages/105ma.html.

Vallotton, C. D. (2009). Do infants influence their quality of care? Infants' communicative gestures predict caregivers' responsiveness. *Infant Behavior & Development*, *32*(4), 351-365. doi:10.1016/j.infbeh.2009.06.001.

von Bertalanffy, L. (1968). *General systems theory*. New York: Braziller.

WHO (2006). *Child growth standards*. Retrieved from http://www.who.int/childgrowth/standards/Technical_report.pdf.

WHO (2007). *WHO Anthro; training course on child growth assessment*. Retrieved from http://whqlibdoc.who.int/publications/2008/9789241595070_C_eng.pdf.

WHO (2010). WHO Anthro for personal computers, version 3.1, 2010: Software for assessing growth and development of the world's children. Geneva: WHO, 2010. Retrieved from http://www.who.int/childgrowth/software/en.

Wilcox, W.D., Gold, B.D., & Tuboku-Metzger, A.J. (1991). Maternal recall of infant birth weight. *Clinical Pediatrics,* 30(8), 509-510.

Wilcox, W. D., Nieburg, P., & Miller, D. S. (1989). Failure to thrive. A continuing problem of definition. *Clinical Pediatrics*, *28*(9), 391-394.

Wong, D. L., Hockenberry, M. J., & Wilson, D. (2003). *Wong's nursing care of infants and children*. Mosby.

Wojcicki, J. M., & Heyman, M. B. (2010). Let's Move--childhood obesity prevention from pregnancy and infancy onward. *The New England Journal of Medicine*, *362*(16), 1457-1459. doi:10.1056/NEJMp1001857.

Wojnar, D (2008). Application of the Barnard parent/caregiver-child interaction model to care of premature infants. In M. De Chesnay, & B. Anderson [Ed] *Caring for the vulnerable : perspectives in nursing theory, practice, and research* (2nd ed.). Sudbury Mass.; Toronto: Jones and Bartlett.

Worobey, J. (1986). Convergence among assessments of temperament in the first month. *Child Development*, *57*(1), 47-55.

Worobey, J., Lopez, M. I., & Hoffman, D. J. (2009). Maternal behavior and infant weight gain in the first year. *Journal of Nutrition Education and Behavior*, *41*(3), 169-175. doi:10.1016/j.jneb.2008.06.005.

Wright, P., Fawcett, J., & Crow, R. (1980). The development of differences in the feeding behaviour of bottle and breast fed human infants from birth to two months. *Behavioural Processes*, *5*(1), 1-20. doi:10.1016/0376-6357(80)90045-5