Associations between mothers' use of food to soothe, feeding mode, and infant weight during early infancy

Megan K. Hupp[a,b], **Peggy C. Papathakis**[a,b], **Suzanne Phelan**[a], **Alison K. Ventura**[a,*]

[a]Center for Health Research, Department of Kinesiology and Public Health, California Polytechnic State University, San Luis Obispo, CA, USA

[b]Department of Food Science and Nutrition, California Polytechnic State University, San Luis Obispo, CA, USA

Abstract

Weight status and rate of weight gain in the first six months postpartum are strong predictors of later obesity; thus, infant feeding practices are an important target for obesity prevention efforts. The use of food to soothe (FTS) is associated with less-favorable eating habits and weight outcomes for older infants and children. However, few studies have examined correlates of use of FTS during early infancy. The primary aim of this cross-sectional study was to explore associations between use of FTS and infant weight status in the first 6 months postpartum. A secondary aim was to identify the combination of maternal and infant characteristics that predicted use of FTS. Mothers of infants aged 6 months or younger (N = 134) completed questionnaires assessing use of FTS, bottle-feeding intensity (i.e., percentage of daily feedings from bottles versus directly from the breast), levels of responsive and pressuring feeding styles, dimensions of infant temperament and eating behaviors, and family demographics. Dyads were observed during feeding to assess maternal sensitivity to infant cues and responsiveness to infant distress and infant clarity of cues and responsiveness to the mother. Infant weight and length at study entry were assessed by a trained research assistant. Use of FTS was not associated with infant weight for age z-score (WAZ), even when bottle-feeding intensity was considered as a moderator. More frequent use of FTS was predicted by the combination of greater levels of pressuring feeding style (p = .005) and infant temperamental negative affectivity (p = .001), and lower levels of infant temperamental surgency/extraversion (p = .018). In conclusion, use of FTS was associated with

*Corresponding author. Center for Health Research, Department of Kinesiology and Public Health, California Polytechnic State University, One Grand Ave, 43A-371, San Luis Obispo, CA, 93407, USA. akventur@calpoly.edu (A.K. Ventura).

dimensions of infant temperament and maternal feeding style, but not with WAZ during early infancy.

Keywords

Use of food to soothe; Responsive feeding; Infant weight status; Breastfeeding; Bottle-feeding

1. Introduction

Rapid weight gain, which leads to higher weight status during early childhood is a strong predictor for obesity and related health morbidities during later childhood, adolescence, and adulthood (Baird et al., 2005; Braun, Kalkwarf, Papandonatos, Chen, & Lanphea, 2018; Ong & Loos, 2006; Stettler & Iotova, 2010; Zheng et al., 2018). In particular, the first 6 months of life is a sensitive period of development (Pray, Food and Nutrition Board, Board on Children Youth and Families, Institute of Medicine, & National Research Council, Pray, Food and Nutrition Board, Board on Children Youth and Families, & Institute of Medicine, & National Research Council, 2015), wherein effects of rapid weight gain and resultant higher weight status are more strongly associated with risk for later obesity compared to effects of rapid weight gain experienced during later developmental periods (Ekelund et al., 2007; Taveras et al., 2011). Subsequently, obesity prevention efforts have started to focus on early infancy as an opportune window for intervention (Lanigan & Singhal, 2009; Lumeng, Taveras, Birch, & Yanovski, 2015; Paul et al., 2009; Perez-Escamilla & Kac, 2013; Young, Johnson, & Krebs, 2012).

One of the earliest modifiable influences on early weight gain trajectories is infant feeding practices (Appleton et al., 2018; Birch & Doub, 2014; Gillman, 2010; Karaolis-Danckert, Gunther, Kroke, Hornberg, & Buyken, 2007). Often highlighted as an ideal feeding style, responsive feeding is the act of being in-tune with the infant's hunger and satiation cues and then responding to these cues in a developmentally appropriate manner that is contingent upon the infant's needs (Perez-Escamilla, Segura-Perez, & Lott, 2017). Thus, a key component of responsive feeding is only feeding the infant when the infant expresses signs of hunger, and then stopping the feeding when the infant expresses signs of satiation. Recent randomized clinical trials illustrate that responsive feeding and parenting can effectively lead to slower, less-rapid weight gain and healthier weight outcomes during infancy (Daniels et al., 2012; Savage, Birch, Marini, Anzman-Frasca, & Paul, 2016; Savage et al., 2018).

Use of food to soothe (FTS) is defined as the act of feeding a child when he/she is upset for reasons other than hunger. Although use of FTS is characterized by responsiveness to child distress and a desire to comfort, it is also characterized by a failure to discriminate between child satiety cues and other cues, thus resulting in a mismatch between the child's need and parent's response. Use of FTS during infancy is common (Jansen et al., 2019), likely because feeding is an effective soothing mechanism (Gray, Miller, Philipp, & Blass, 2002; Macht & Simons, 2011; Smith, Fillion, & Blass, 1990). However, greater use of FTS during infancy is associated with greater infant weight status (Stifter, Anzman-Frasca, Birch, & Voegtline, 2011) and greater increase in infant weight status from 6- to 18-months (Stifter

& Moding, 2015). Additionally, more frequent use of FTS at 6 months predicts overweight status at 6 years of age (Jansen et al., 2019). In studies of older children, parent's use of FTS is associated with less favorable child outcomes, such as greater tendencies toward emotional eating (Braden et al., 2014), eating in the absence of hunger (Blissett, Haycraft, & Farrow, 2010), and high consumption of unhealthy snacks (Sleddens et al., 2014).

Taken together, these findings suggest primary prevention efforts should aim to help parents discriminate between satiety and other distress cues and learn a range of soothing mechanisms, beyond feeding, to comfort their infants. However, limitations of these previous studies highlight opportunities for further research. For example, studies of use of FTS during infancy included samples that combined younger infants who had not yet been introduced to complementary foods and beverages (4 months) and older infants who had been introduced to complementary foods and beverages (5–12 months), making it difficult to parse out effects of use of FTS during breast- and/or bottle-feeding from effects when diet composition is more complex (Jansen et al., 2019; Rametta, Mallan, Daniels, & de Jersey, 2015; Stifter et al., 2011). Parents of older children report they typically offer more palatable, high-energy foods to soothe (Sherry et al., 2004), which may interact with increased feeding frequency to impact weight status. In addition, previous studies did not explore the possibility that associations between use of FTS and weight status may differ for infants who are predominantly breastfeeding compared to infants who are predominantly bottle-feeding. Although breastfeeding mothers report more frequent use of FTS compared to formula-feeding mothers (Rametta et al., 2015), the breastfeeding infant typically engages in a mix of nutritive and non-nutritive sucking during feeding (Mizuno & Ueda, 2006). In contrast, the bottle-feeding infant engages almost exclusively in nutritive sucking (Mizuno & Ueda, 2006). Thus, it is plausible for a breastfeeding infant to be soothed by latching onto the breast without subsequent calorie intake, whereas this would be less likely for a bottle-feeding infant. Further research is needed to understand use of FTS during early infancy when infants are exclusively breast- and/or bottle-feeding, which would allow for a better understanding of potential associations between feeding mode and use of FTS, as well as possible differential associations between use of FTS and weight gain trajectories for breastfed versus bottle-fed infants.

Few studies have explored the association of FTS with maternal feeding style (e.g., responsive or pressuring feeding styles) or with infant characteristics beyond infant temperament, such as clarity of cues, responsiveness to the mother, or eating behaviors (e.g., enjoyment of food, food responsiveness, and satiety responsiveness). Although responsive feeding is associated with healthier infant outcomes, previous research also illustrates significant, positive associations between responsive feeding and use of FTS (Stifter et al., 2011; Stifter & Moding, 2015). These previous studies used self-reported measures of responsive feeding; thus, more objective measures may provide additional insights regarding how maternal sensitivity and responsiveness to infant cues is associated with use of FTS. In addition, previous research suggests child temperament is associated with use of FTS, as greater use of FTS is associated with greater levels of negative affectivity and lower levels of surgency/extraversion (Stifter et al., 2011; Stifter & Moding, 2018), however, few studies have examined the association between the use of FTS and other infant characteristics that may influence mother-infant interactions, such as clarity of cues or eating behaviors.

Ventura, Sheeper, and Levy (2019) showed that greater infant clarity of cues was associated with greater maternal sensitivity and argued that it might be easier for a mother to be responsive to her infant when her infant is better able to express his/her needs and is responsive to his/her mothers' attempts to soothe. Additionally, dimensions of infants' eating behaviors, such as enjoyment of food, responsiveness to food, or satiety responsiveness, may also influence the mother's choice to use FTS for infant distress. In sum, further examination of the combination of maternal and infant characteristics that predict use of FTS would provide additional insights into potential targets for tailored prevention efforts.

To this end, the purpose of this secondary analysis was to explore associations between the use of FTS and infant weight in the first 6 months postpartum. We hypothesized that more frequent use of FTS would predict greater weight-for-age z-score (WAZ) during early infancy, but that this association would be moderated by the mode of feeding, with greater use of FTS predicting greater WAZ for predominately bottle-fed infants but not for predominately breast-fed infants. A secondary aim of this study was to explore associations between use of FTS and maternal and infant characteristics to identify the combination of characteristics of mothers (i.e., sociodemographics, responsive and pressuring feeding styles, observed sensitivity to infant cues and responsiveness to infant distress) and infants (i.e., infant temperament, clarity of cues, responsiveness to the mother, and eating behaviors) that significantly predicted use of FTS during early infancy. We hypothesized that greater use of FTS would be predicted by the combination of: 1) greater maternal-reported responsive and pressuring feeding styles, 2) greater observed scores for maternal sensitivity to infant cues and responsiveness to infant distress, 3) greater infant negative affectivity, enjoyment of food, and food responsiveness, and 4) lower infant surgency/extraversion, satiety responsiveness, clarity of cues, and responsiveness to the mother.

2. Methods

2.1. Overview/participants

This study was a secondary analysis of pooled data from four previous infant feeding studies [for more details, see (Ventura & Golen, 2015; Ventura & Hernandez, 2019; Ventura, Hupp, & Lavond, 2021; Ventura, Levy, & Sheeper, 2019)]; similar methodologies were used for all four studies. These studies took place in Philadelphia, PA and San Luis Obispo, CA between June 2013 to January 2020. For all studies, mothers with infants under 6 months of age were recruited; data for all participants in these studies were included in this secondary analysis (pooled n = 134).

Eligibility criteria for infants included: born full-term (>37 weeks), less than 6 months of age, no developmental delays, not on any medication, and not yet introduced to solid foods. Eligibility criteria for mothers included: between 18 and 40 years of age and did not smoke during pregnancy. Mothers were recruited through online advertisements (e.g., Craigslist, Facebook), advertisements in local WIC clinics, announcements in infant feeding and birthing classes, flyers displayed locally and distributed to nearby businesses, and word of mouth. The procedures for studies were approved by the Drexel University (Ventura & Golen, 2015) or California Polytechnic State University (Ventura & Hernandez, 2019;

Ventura et al., 2021; Ventura, Levy, & Sheeper, 2019) Institutional Review Boards. All participants gave written and oral consent before participating.

2.2. Design

The study design was the same across all studies used for this secondary analysis. All studies were cross-sectional, within-subject experiments. Mother-infant dyads visited our laboratory two different days for approximately two hours on each day. The two visits were separated by one day at minimum and by one week at maximum. Both visits started at the same time of day to control for changes in the circadian rhythm of the infant (Matheny, Birch, & Picciano, 1990). The research assistant encouraged the mothers to schedule the two visits at a time when their infants would be most ready to feed. Questionnaires were administered to mothers either electronically or as a paper document and either before or after the observation depending on randomization. The timing of survey administration was counterbalanced across the sample to reduce bias. Supplementary Table 1 summarizes the measures described below.

2.3. Questionnaires

Use of FTS.—The Basic Baby Needs Questionnaire (BBNQ) was used to measure the extent to which mothers use FTS in different situations (Stifter et al., 2011; Stifter & Moding, 2015). This maternal-reported 13-item scale assessed how often the mothers used FTS in general as well as in different scenarios (Example item: "How likely are you to use food to soothe when you are stressed?"). The items are scored on a Likert scale of 0–5 with 0 being "Never," 3 being "Sometimes," and 5 being "Often." The use of FTS subscale has been previously tested on infants and has shown modest convergent validity with similar parental feeding styles and beliefs and good reliability ($\alpha = 0.86$) (Stifter et al., 2011).

Feeding Type and Bottle-feeding Intensity.—Within the BBNQ, the mothers were asked a question about how their baby is currently being fed (breastfeeding only, formula-feeding only, or breast- and formula-feeding). Following this question, mothers were asked to use a sliding bar to specify the percentage of daily feedings (defined as breast milk or formula) that their infant received from a bottle versus directly from the breast (referred to from hereon as bottle-feeding intensity).

Infant Feeding Style.—The Infant Feeding Style Questionnaire (IFSQ) was used to assess infant feeding style. The IFSQ is a maternal-reported measure that is used to better understand parental feeding practices and beliefs (Thompson et al., 2009). The five feeding styles assessed through this questionnaire are: Responsive, Pressuring, Restrictive, Laissez-Faire, and Indulgent. For this study, only the Responsive (example item: "I pay attention when my child seems to be telling me that s/he is full or hungry") and Pressuring (example item: "The best way to make an infant stop crying is to feed him or her") feeding subscales were utilized because these two feeding styles have been previously associated with the use of FTS (Stifter et al., 2011; Stifter & Moding, 2015). The IFSQ has been validated in diverse samples and subscales and has demonstrated acceptable internal reliability ($\alpha = 0.60$–0.75) (Thompson et al., 2009).

Infant Temperament.—The Infant Behavior Questionnaire - Revised Very Short Form (IBQ-RVS) was used to assess infant temperament. The IBQ-RVS is a 37-item instrument (Putnam, Helbig, Gartstein, Rothbart, & Leerkes, 2014) that was updated from the Infant Behavior Questionnaire - Revised (Gartstein & Rothbart, 2003) in order to decrease assessment burden. The IBQ-R VSF measures three dimensions of infant temperament: Negative Affectivity, Surgency/Extraversion, and Orientation/Regulation Capacity. For the purposes of this study, only the Negative Affectivity and Surgency/Extraversion dimensions were explored. Negative Affectivity is characterized by sadness, distress to limitations, and fear (example item: "When you were busy with another activity, and your baby was not able to get your attention, how often did s/he cry?"). Surgency/Extraversion is characterized by impulsivity, high activity level, high-intensity pleasure, and low shyness (example item: "How often during the week did your baby move quickly toward new objects?"). All of the questionnaire items were scored on a Likert scale of 0–7, with 0 being "Never" and 7 being "Always." The IBQ-RVS has been validated in diverse populations of mothers of infants younger than three months and up to three years old; subscales demonstrated good internal consistency: Negative Affectivity ($\alpha = 0.78$) and Surgency/Extraversion ($\alpha = 0.77$) (Putnam et al., 2014).

Infant Eating Behavior.—The Baby Eating Behavior Questionnaire (BEBQ) was used to assess infant eating behavior. The BEBQ is an 18-item instrument that has been adapted from the Children's Eating Behavior Questionnaire and validated for infants that are less than 2 years old (Llewellyn, van Jaarsveld, Johnson, Carnell, & Wardle, 2011). The BEBQ has 4 subscales: enjoyment of food, food responsiveness, slowness in eating, and satiety responsiveness. For this study, the enjoyment of food, food responsiveness, and satiety responsiveness subscales were used. All of the questionnaire items from each subscale are scored on a Likert scale of 0–5, with 0 being "Never" and 5 being "Always." The enjoyment of food subscale contains 4 items that assess the mother's perception of the infant's pleasure during eating (example item: "My baby enjoys feeding time"). The food responsiveness subscale has 5 items that assess infant responsiveness to external cues to eat (example item: "Even when my baby has just eaten well, s/he is happy to be fed again if offered"). The satiety responsiveness subscale contains 2 items that assess infant self-regulation of intake and expression of satiation (example item: My baby gets full before taking all the milk I thought s/he should have"). Llewellyn et al. (2011) reported internal consistency for the enjoyment of food subscale was $\alpha = 0.81$, food responsiveness subscale was $\alpha = 0.79$, and the satiety responsiveness subscale was $\alpha = 0.73$.

Family Demographics.—Family demographics were assessed using a questionnaire developed by the researcher team. These questionnaires assessed mothers' education level, race/ethnicity, participation in federal assistance programs (i.e., WIC), marital status, parity, and age, and family income level.

2.4. Feeding observations

Procedure.—At both visits, the mothers were instructed to feed their infant as they normally would at home. At one of the visits there was an experimental condition (e.g., iPad was used, an opaque bottle was used, or the mother was asked to bottle-feed instead

of breastfeed). The other visit was a control, with the mother using her typical mode of feeding. The order of feeding condition was randomized and counterbalanced. After a brief acclimation period and when the mother signified that she was ready to start the feeding, video cameras were used to record the entire feeding interaction (GoPro Hero5 Black, California, USA and Canon VIXIA HF M41 full HD camcorder; Canon). Depending on the study, either one camera was placed about 10 feet in front of the dyad or 3 small GoPros were placed on three different sides of the dyad, each about 2–4 feet away. For the purposes of this study, only the video footage from the control conditions for each study were analyzed to increase equivalence of measures across the combined dataset and to provide a representation of a typical feeding interaction between the mother and infant.

Video Analysis.—Video recordings from each feeding session were coded by trained raters who were blinded to the study hypotheses. The Nursing Child Assessment Parent-Child Interaction Feeding Scale (NCAFS) was used for the coding scheme (Oxford & Findlay, 2015). This scale has been widely used to observe and quantitatively measure parent-infant interactions during a feeding session. For the purposes of this study, four subscales were used: Maternal Sensitivity to Cues, Maternal Responsiveness to Infant Distress, Infant Clarity of Cues, and Infant Responsiveness to Caregiver.

The Maternal Sensitivity to Cues subscale contains 16 items that measure the mother's ability to accurately read her infant's hunger and satiation cues during the feeding interaction (Example item: "Caregiver comments verbally on child's satiation cues before terminating the feeding"). The mother is scored on a scale of 0–16 with a higher score representing greater sensitivity to the infant's feeding cues. The Maternal Responsiveness to Infant Distress subscale contains 11 items that primarily focus on the mother's attempts to relieve her infant's distress (i.e., crying, whining, choking, etc.). These attempts include altering her level of touch or positioning, vocalizing to her baby, and starting or stopping the feeding. The mother is scored on a scale of 0–11 with a higher score representing greater responsiveness to infant distress. The Infant Clarity of Cues subscale contains 15 items that measure the infant's ability to communicate to his/her mother and express needs. These cues include signaling a readiness to eat, demonstrating satiation, having periods of alertness, and initiating eye contact with the caregiver during the feeding. Infants receive a score of 0–15, where a higher score signifies greater clarity of cues. The Infant Responsiveness to Caregiver subscale contains 11 items that all measure the infant's ability to respond to the caregiver's efforts to interact. Some of these items include smiling at the caregiver during the feeding, reaching out to the caregiver during the feeding, and showing potent disengagement cues during the last half of the feeding. The infant is scored on a scale of 0–11 with a higher score representing higher responsiveness to their caregiver. The NCAFS has been validated for infants aged up to 1 year, for both breast- and bottle-feeding observations, and for home- and lab-based observations and reported Cronbach's alphas for subscales range between $\alpha = 0.60–0.85$ (Oxford & Findlay, 2015).

All coders received training from a certified NCAFS trainer and did not begin coding until receiving an NCAFS coding certificate. Additional inter-rater reliability assessments were determined by common coding of 10% of the study videos and intra-rater reliability was determined by double-coding of 10% of the study videos. Inter-rater reliability and

intra-rater reliability were established using Pearson's correlation coefficients; both were r < 0.85.

2.5. Anthropometric measures and weight-for-age Z-scores

Infant weight at birth was reported by the mother. Previous research illustrates mothers can accurately recall infant birth weight within 6 months of delivery and maternal-reported infant birth weight correlates strongly with measured weight from medical records (Petersen, Mitchell, Van Bennekom, & Werler, 2019; Seidman, Slater, Ever-Hadani, & Gale, 1987). Infant weight at study entry was measured in the lab using triplicate measures on an infant scale (model 374, Seca) and then averages of the triplicate values were calculated. The average weight values were normalized to sex- and age-specific z scores using World Health Organization Anthro software, version 3.2.2 (WHO Multicenter Growth Reference Study Group, 2006). Mothers reported their prepregnancy weight and height and reported values were used to calculate maternal prepregnancy Body Mass Index (BMI = weight [kg]/ height $[m]^2$). Mothers were then classified as Not Overweight/Obese prior to pregnancy if their prepregnancy BMI was less than 25 or Overweight/-Obese prior to pregnancy if their prepregnancy BMI was 25 or greater.

2.6. Statistical analyses

Statistical analyses were performed using JMP Pro version 14 (JMP, Cary, NC). Missing data were minimal and were handled by listwise deletion; details regarding the amount of missing data and analytical sample sizes for the models described below are provided in table footnotes. Descriptive statistics were calculated and bivariate associations between study variables were assessed. During preliminary analyses, we noted that reported birth weight for 9 infants met the criteria for small for gestational age (SGA, defined as weight-for-age percentile score <10%) (Schlaudecker et al., 2017). Given infants born SGA are at higher risk for exhibiting rapid weight gain (i.e., catch-up growth) (Ong, Ahmed, Emmett, Preece, & Dunger, 2000), analyses with WAZ as the dependent variable were run with and without these 9 infants to examine whether these infants had undue influence on findings.

To examine associations between use of FTS and WAZ during early infancy, preliminary analyses using stepwise regressions were conducted to identify which sociodemographic variables were significant predictors of WAZ. Analyses revealed birth WAZ, maternal race/ ethnicity, and parity were all significantly related to WAZ and therefore were included as covariates in all predictive models. Additionally, infant age at study entry was included in all predictive models to control for the variance in time that elapsed from birth to study entry. The categorical variable for study was also included as a covariate to account for differences in study location, participant demographics, and study design. Multiple regression was used to test for associations between FTS and WAZ while controlling for relevant sociodemographics. To test whether bottle-feeding intensity moderated the relationship between the use of FTS and WAZ, effects of bottle-feeding intensity and the interaction between FTS and bottle-feeding intensity were added to the multiple regression model.

To examine the combination of maternal and infant characteristics that predicted use of FTS, preliminary analyses using stepwise regressions were conducted to identify which sociodemographic variables were significant predictors of FTS. These analyses revealed mother's age, mother's pre-pregnancy BMI, and the study were all significantly related to the use of FTS and therefore were included as covariates in the predictive model. Multiple regression was then used to regress use of FTS on characteristics of mothers (observed maternal sensitivity to cues and responsiveness to distress, maternal-reported responsive and pressuring feeding styles) and infants (negative affectivity, surgency/extra-version, food responsiveness, enjoyment of food, and satiety responsiveness, observed clarity of cues and responsiveness to caregiver). Effects with p-values < .05 were considered significant.

3.   Results

3.1.   Sample characteristics

Table 1 presents sample characteristics. Mean age for infants was 14.8 weeks (SD = 7.1, range = 1.7–31.0 weeks). Mean age for mothers was 30.6 years (SD = 5.2, range = 18.0–40.4 years). Most dyads were living in California (78%) and most mothers reported a race/ethnicity of Non-Hispanic White (60%), a family income greater than $75,000 (50%), completion of a bachelor's or graduate degree (63%), being married (74%), primiparous (55%), and having a normal pre-pregnancy BMI (57%).

Approximately 63% of mothers were exclusively breastfeeding, 18% reported a combination of breast- and formula feeding, and 19% reported exclusively formula feeding. Mean bottle-feeding intensity was 39.8% (SD = 38.9, range = 0–100). Mothers who were exclusively breastfeeding reported lower percentage of daily feedings given from a bottle (M = 18.9, SD = 23.6) compared to mothers who reported any breastfeeding (M = 52.6, SD = 31.0) or exclusive formula-feeding (M = 100, SD = 0).

Average FTS score was 2.6 (SD = 0.9, range = 1–5). The mean WAZ at birth was 0.3 (SD = 0.9, range = −1.8 – 3.2) and the mean WAZ at study entry was 0.0 (SD = 0.8, range = −1.6 – 1.9).

3.2.   Correlations among study variables

Bivariate correlations between use of FTS and other variables of interest are presented in Table 2. The use of FTS was negatively associated with bottle-feeding intensity (r = −0.20, p = .021). Additionally, the use of FTS was positively associated with pressuring feeding (r = 0.20, p = .019) and infant negative affectivity (r = 0.41, p < .001). WAZ at study entry was negatively correlated with infant satiety responsiveness (r = −0.24, p = .005).

3.3.   Associations between use of FTS and infant weight-for-age Z-score during early infancy

Multiple regression analysis regressing WAZ on use of FTS while controlling for infant birth WAZ, infant age at the time of study participation, mother race/ethnicity, mother parity, and study revealed that the use of FTS was not a significant predictor of infant WAZ (F [1,130] = 0.08, p = .778; Table 3, Model 1). Addition of bottle-feeding intensity and

interaction between bottle-feeding intensity and FTS further revealed that neither the use of FTS (F $[1,127] = 0.05$, p = .766) nor bottle-feeding intensity (F $[1,127] = 0.63$, p = .428) significantly predicted WAZ (Table 3, Model 2). Additionally, the interaction between use of FTS and bottle-feeding intensity was not significant (F $[1,127] = 1.00$, p = .319). These results remained unchanged when infants who were classified as SGA at birth were excluded.

3.4. Maternal and infant characteristics predicting the use of FTS

Table 4 presents findings from a multiple regression model examining the combination of maternal and infant characteristics that predicted the use of FTS. Maternal reported pressuring feeding style (F $[1,123] = 8.28$, p = .005), infant negative affectivity (F $[1,123] = 13.10$, p = .001), and infant surgency/extraversion (F $[1,123] = 5.83$, p = .018) were significant predictors for the use of FTS. Significant covariates included Study (F $[1,123] = 6.12$, p = .001) and mothers' prepregnancy weight status (F $[1,123] = 5.65$, p = .019). In particular, mothers with overweight/obesity prior to pregnancy reported significantly less frequent use of FTS than mothers classified as not overweight/obese prior to pregnancy. These results suggest that the combination of higher levels of pressuring feeding style and infant negative affectivity and lower levels of infant surgency/extraversion and maternal prepregnancy weight status predicted more frequent use of FTS during early infancy. Maternal reported responsive feeding and infant eating behavior and observed maternal and infant responsiveness were not significant predictors for the use of FTS.

4. Discussion

The aim of the present study was to explore associations between mothers' use of FTS, bottle-feeding intensity (defined as percentage of daily feedings given from a bottle versus directly from the breast), and infant weight status during the first 6 months postpartum. The present study addressed a gap in the literature by focusing on infants who were 6 months or younger, which is in contrast to the broader age ranges included in previous studies of use of FTS during infancy (Rametta et al., 2015; Stifter et al., 2011; Stifter & Moding, 2015). Therefore, the present study allowed for a focused examination of possible associations between FTS and infant weight status prior to the introduction of complementary foods and beverages and during an early critical window of development.

Based on previous work illustrating associations between use of FTS and weight status in older infants and children (Jansen et al., 2019; Stifter et al., 2011; Stifter & Moding, 2015), we hypothesized that a greater use of FTS would be associated with a greater WAZ during early infancy. However, this hypothesis was not supported. One possible explanation for discrepancies between the findings of the present study and those of previous research is that the short timespan between birth to study entry was not enough time to see potential associations between FTS and WAZ. Early rates of weight gain and weight status are meaningful, as rapid weight gain during periods as short as the first 8 days after birth are associated with higher weight status and greater risk for obesity during childhood (Stettler et al., 2005). However, other studies of associations between use of FTS and infant weight have assessed weight gain over longer periods (Jansen et al., 2019; Stifter et al., 2011; Stifter

& Moding, 2015). Thus, it is possible that more time is needed for mothers' use of FTS or emotional feeding to influence the infant's eating behavior and subsequent weight status. In addition, non-significant associations between FTS and infant weight status may have been due to the fact that infants in this study had not yet been introduced to solid foods. Previous studies included samples of infants >3 months old, which likely included many infants who had been introduced to solid foods (Jansen et al., 2019; Stifter et al., 2011; Stifter & Moding, 2015). In the present study, infants were only being fed breastmilk and/or formula; it is possible that the use of FTS before the introduction of solids was not associated with infant weight status because of the limited variability in nutrient- and energy-density in the infants' diets.

We noted a negative correlation between bottle-feeding intensity and use of FTS, which is consistent with previous research illustrating breastfeeding mothers report more frequent use of FTS (Rametta et al., 2015). This finding makes intuitive sense given the relative ease of offering the breast versus a bottle (which necessitates more preparation) to soothe an infant, and previous research illustrates breastfeeding uniquely alleviates infant distress and serves as an effective analgesic due to the calming properties of skin-to-skin contact, suckling, and sweet taste (Benoit, Martin-Misener, Latimer, & Campbell-Yeo, 2017; Efe & Ozer, 2007; Gray et al., 2002). However, we also hypothesized that bottle-feeding intensity would moderate the relationship between the use of FTS and WAZ, with a stronger positive relationship between the use of FTS and weight status for infants who were predominantly bottle-fed compared to infants who were predominantly fed directly from the breast; this hypothesis was not supported. One possible explanation for these results might be that the questionnaire asked mothers how they are currently feeding their infant and did not ask how long this bottle-feeding intensity has been occurring. Longitudinal studies of infant feeding practices suggest that infant feeding in the first 6 months can be complex and it is common for mothers to transition between different feeding modes during this time (Karmaus, Soto-Ramirez, & Zhang, 2017; Ventura, 2017). In the present study, it is possible that some mothers switched feeding methods from birth to study entry and our focus on current feeding mode did not adequately reflect interactions between feeding mode and FTS during early infancy. However, it is also possible that use of FTS during the period of exclusive milk feeding does not contribute to excess calorie intake, regardless of whether the breast or the bottle are used to soothe the infant.

A secondary aim of this study was to expand our understanding of characteristics of mothers and infants that predicted use of FTS by examining whether objective and subjective measures of maternal sensitivity and responsiveness to child distress and infant temperament and eating behaviors were associated with use of FTS. In terms of maternal characteristics, only maternal-reported pressuring feeding style was associated with use of FTS, which corresponds with previous research (Stifter et al., 2011; Stifter & Moding, 2015). This finding also makes intuitive sense because pressuring feeding encompasses the act of feeding a child in the absence of hunger and in response to emotional (e. g., infant crying) and/or environmental (e.g., the amount of milk left in the bottle) cues (Thompson et al., 2009). Indeed, the pressuring feeding style subscale of the IFSQ includes items that directly measure use of FTS (e.g., "The best way to make an infant stop crying is to feed him or her"), illustrating use of FTS is conceptualized as a component of a pressuring feeding

style. Previous research has also highlighted significant associations between use of FTS and responsive feeding (Stifter et al., 2011; Stifter & Moding, 2015), but similar associations between subjective or objective measures of maternal sensitivity and responsiveness were not seen in the present study. It is important to note that mothers in the present study had relatively high scores for maternal-reported responsive feeding style and observed sensitivity to infant cues and responsiveness to infant distress; low variability in these variables may have hindered our abilities to identify associations between responsiveness and use of FTS. In addition, we included mothers' prepregnancy weight status as a covariate in our exploration of predictors of use of FTS and noted that mothers with overweight/obesity prior to pregnancy were significantly less likely to report use of FTS than mothers without overweight/obesity. These findings are consistent with a previous study of Chinese mothers with 1-35-month-old infants, which illustrated mothers with overweight reported using FTS less often and controlled feeding more often than mothers without overweight (Jingxiong et al., 2009). However, few studies have examined associations between maternal weight status and use of FTS during early infancy; given well-documented associations between maternal obesity, breastfeeding initiation and duration, and feeding practices during later childhood (Thompson, 2013), further research is needed to understand mechanisms underlying associations between mothers' prepregnancy weight status and use of FTS.

In terms of infant characteristics, only dimensions of infant temperament – infant negative affectivity and surgency/extraversion – were significant predictors of maternal use of FTS. Noted positive associations between infant negative affectivity and use of FTS have been remarkably consistent across studies of use of FTS (Stifter & Moding, 2019), and may reflect findings that mothers of infants with greater levels of negative affectivity face a unique set of early parenting challenges, such as difficulty with infant feeding, negative feelings toward infants in general, decreased maternal self-confidence, and decreased parental self-efficacy (Galler et al., 2004; Pizur-Barnekow, 2006; Solmeyer & Feinberg, 2011). Although infant surgency has been associated with impulsivity (Burton et al., 2011), infants with lower surgency/extraversion also exhibit higher irritability (Stifter & Moding, 2018) and lower levels of self-comforting in the face of social stressors (Planalp & Braungart-Rieker, 2015), which may explain why the combination of higher levels of negative affectivity and lower levels of surgency/extraversion predicted use of FTS. Taken together, mothers of infants with greater levels of negative affectivity and lower levels of surgency/extraversion may struggle to soothe their fussy infants, leading them to use FTS; these mothers may be important targets for tailored prevention efforts.

Because the importance of both mothers' and infants' contributions to the quality and outcome of dyadic interactions has been well-established (Ainsworth & Bell, 1969; Bell & Ainsworth, 1973; Cohn & Tronick, 1988; Lavelli & Fogel, 2013), we hypothesized that infant clarity of cues, responsiveness to the caregiver, and eating behaviors would predict use of FTS. It is conceivable that mothers would have trouble discriminating between infant cues signaling hunger versus other needs when their infants have low clarity of cues or receptiveness to the mothers' attempts at interaction, or high levels of food responsiveness and low levels of satiety responsiveness. Indeed, a recent study of 413 mothers of 4-month-old infants illustrated mothers who reported their infants exhibited higher levels of food responsiveness also reported a higher use of food to calm (Mallan, Sullivan, de Jersey, &

Daniels, 2016). Additionally, infant clarity of cues is positively associated with maternal sensitivity to infant cues and responsive feeding style (Ventura, Sheeper, & Levy, 2019), supporting the possibility that infant cues and eating behaviors provide important inputs and feedback for mothers' feeding decisions (Hodges, Hughes, Hopkinson, & Fisher, 2008; McNally et al., 2016). Although similar associations between use of FTS and these infant characteristics were not seen in the present study, further research aimed at understanding how bidirectional influences between mothers and infants may influence mothers' feeding practices and styles is warranted.

There are several limitations of the present study that would be important to address in future research. The present study was a secondary analysis of data that was not collected with the intended purpose to answer the research questions posed within this study. Although study was included as a covariate in all statistical models, differences in study design and location between the four studies in this secondary analysis may have influenced mothers' responses or dyads' behaviors in ways that biased our findings. Although counterbalanced, the timing of survey administration relative to the observation may have introduced bias, as some mothers might have altered their behavior based on their responses to the survey. Additionally, this study was cross-sectional and noted associations cannot be interpreted as causal. Although the sample size included in this study was comparable to that of other similar studies, it is possible that a larger sample size was needed. *Post hoc* power analyses suggested a minimum sample size of 238 participants would be needed to see a significant effect with a power of 0.80 (data not shown). Findings from this study may not be generalizable to a more diverse population given the majority of mothers in this study had a university education, a family income greater than $75,000, and were primiparous, which might have influenced their feeding practices. Additionally, slightly less than 20% of the sample reported they exclusively formula-fed; it is possible this low prevalence of formula-feeding precluded our ability to identify associations between FTS and infant weight status. Further research with larger, more diverse samples is warranted.

5. Conclusions

The present study explored mothers' use of FTS during the first 6 months postpartum and prior to the introduction of complementary foods and beverages. We found that mothers' use of FTS was not significantly associated with infant weight status during early infancy, even when considering bottle-feeding intensity as a moderator. More frequent use of FTS was associated with the combination of greater levels of pressuring feeding style, greater levels of infant negative affectivity, and lower levels of infant surgency/extraversion. Mothers' levels of responsive feeding style, sensitivity to infant cues, and responsiveness to infant distress, and infants' clarity of cues, responsiveness to caregiver, and eating behaviors were not significant predictors for the use of FTS. Evidence that rapid infant weight gain is a strong predictor for later obesity continues to mount, and so does evidence to support the benefits and protective effects of responsive feeding and parenting. Future studies should continue to explore the relationships between non-responsive feeding practices and infant weight gain trajectories to understand the most effective targets for early prevention and intervention efforts.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Sample characteristics (N = 134).

	n	%
Infant Sex, % female	66	49.3
Study Location		
California	105	78.4
Pennsylvania	29	21.6
Family Income		
Less than $15,000	24	17.9
$15,000 - $35,000	24	17.9
$35,000 – $75,000	14	10.4
Greater than $75,000	63	47.0
Not Reported	9	6.7
WIC Participation, % participating		
Yes	39	29.1
No	93	69.4
Not Reported	2	1.5
Education		
Did not Complete High School	2	1.5
High School Degree	21	15.7
Some College/Vocational Degree	26	19.4
Bachelor's or Graduate Degree	83	61.9
Not Reported	2	1.5
Race/Ethnicity		
Non-Hispanic White	80	59.7
Non-Hispanic Black	21	15.7
Hispanic	12	9.0
Other	21	15.7
Marital Status, % married		
Married	99	73.9
Not Married	34	25.4
Not Reported	1	0.7
Parity, % primiparous		
Primiparous	72	53.7
Multiparous	60	44.8
Not Reported	2	1.5
Pre-Pregnancy BMI Classification		
Overweight or Obese	56	41.8
Not Overweight or Obese	74	55.2
Not Reported	4	3.0
Feeding Type		
Exclusive Breastfeeding	85	63.4

	n	%
Any Breastfeeding	24	17.9
Exclusive Formula-feeding	25	18.7

BMI, Body Mass Index, WIC = Supplemental Nutrition Program for Women, Infants, and Children.

Table 2

Intercorrelations among study variables.

Variable	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. FTS	0.10	0.06	**-0.20** *	-0.05	**0.20** *	-0.11	-0.15	-0.02	-0.14	**0.41** ***	-0.13	0.10	0.10	0.09
2. Birth WAZ		**0.32** ***	-0.10	0.04	0.04	-0.06	0.02	0.08	0.08	**0.17** *	0.10	-0.13	0.13	0.00
3. WAZ at Study Entry			0.09	0.12	-0.09	0.03	-0.10	-0.04	0.02	-0.01	0.05	-0.00	0.17	**-0.24** **
4. Bottle-feeding Intensity				-0.08	**0.22** *	**-0.45** ***	-0.05	-0.04	-0.03	-0.17	0.15	-0.06	-0.05	-0.09
Maternal Characteristics														
Maternal-Reported														
5. Responsive Feeding					0.07	0.10	0.03	0.11	0.16	0.00	0.14	-0.07	-0.08	0.04
6. Pressuring Feeding						**-0.28** **	-0.14	-0.08	**-0.30** ***	0.05	0.09	0.02	**0.22** **	0.00
Observed														
7. Sensitivity to Infant Cues							**0.28** **	**0.45** ***	**0.53** ***	0.05	-0.01	-0.09	-0.06	0.07
8. Response to Distress								0.05	0.03	0.00	0.05	-0.14	-0.05	0.00
Infant Characteristics														
Observed														
9. Clarity of Cues									**0.56** ***	0.05	0.06	0.18	0.00	0.05
10. Response to Caregiver										0.05	**0.25** **	-0.02	-0.09	0.13
Maternal-Reported														
11. Negative affectivity											**0.39** ***	-0.15	**0.25** **	**0.25** **
12. Surgency/Extraversion												-0.12	0.03	0.11
13. Enjoyment of Food													-0.10	**-0.33** ***
14. Food Responsiveness														**0.21** *
15. Satiety Responsiveness														–

Bottle-feeding intensity = percent of daily feedings from a bottle, FTS = average reported score for use of food to soothe, WAZ = weight-for-age z-score.

*
p < .05

**
p < .01

***
p < .001.

Table 3

Multiple Regression Model for use of FTS Predicting WAZ during Early Infancy.

	Model 1[a]			Model 2[b]		
	Estimate	Std Error	95% CI	Estimate	Std Error	95% CI
Intercept	−0.38	0.31	(−0.96, 0.19)	−0.40	0.30	(−1.00, 0.20)
Birth WAZ	0.29***	0.08	(0.14, 0.44)	0.30***	0.08	(0.15, 0.46)
Infant Age	0.01	0.01	(−.01, 0.03)	0.01	0.01	(−0.01, 0.03)
Race/Ethnicity						
Non-Hispanic White	Reference	–	–	Reference	–	–
Non-Hispanic Black	0.33	0.34	(−0.34, 0.99)	0.30	0.36	(−0.42, 1.01)
Hispanic	0.49	0.25	(−0.00, 0.99)	0.51*	0.26	(0.00, 1.02)
Other	−0.16	0.19	(−0.54, 0.22)	−0.16	0.19	(−0.54, 0.23)
Parity						
Primiparous	Reference	–	–	Reference	–	–
Multiparous	0.20	0.13	(−0.07, 0.47)	0.18	0.14	(−0.10, 0.45)
Study						
Study A (Ventura et al., 2021)	Reference	–	–	Reference	–	–
Study B (Ventura, Levy, & Sheeper, 2019)	0.06	0.25	(−0.44, 0.56)	0.12	0.26	(−0.40, 0.63)
Study C (Ventura & Golen, 2015)	−0.24	0.31	(−0.87, 0.38)	−0.41	0.37	(−1.14, 0.33)
Study D (Ventura & Hernandez, 2019)	−0.13	0.18	(−0.49, 0.22)	−0.14	0.19	(−0.51, 0.23)
FTS	0.02	0.07	(−0.12, 0.16)	0.02	0.08	(−0.13, 0.17)
Bottle-Feeding Intensity				0.00	0.00	(−0.00, 0.01)
FTS x Bottle-Feeding Intensity[c]				−0.00	0.00	(−0.01, 0.00)

Birth WAZ, infant weight-for-age z-score at birth; FTS, Food to Soothe; Bottle-feeding intensity, percent of daily feedings from a bottle.

*
p < .05

**
p < .01

***
p < .001.

Note: Preliminary analyses using stepwise regression was used to identify relevant covariates; birth WAZ, maternal race/ethnicity, and parity were all significantly related to WAZ and therefore were included as covariates. Additionally, infant age at study entry was included to control for the variance in time that elapsed from birth to study entry and the categorical variable for study was included to account for differences in study location, participant demographics, and study design.

[a]$R^2 = 0.20$, $F = 3.05$, $p = .002$; $n = 131$ due to 1 dyad missing data on use of FTS and 2 dyads missing data for parity.

[b]$R^2 = 0.21$, $F = 2.55$, $p = .005$; $n = 128$ due to 1 dyad missing data on use of FTS, 2 dyads missing data for parity, and 3 dyads missing data for bottle-feeding intensity.

[c]Use of FTS and Bottle-feeding Intensity were mean-centered.

Table 4

Maternal and infant characteristics predicting use of food to soothe (FTS).

	Estimate	Std Error	95% CI
Intercept	1.24	1.69	(−2.11, 4.60)
Maternal Characteristics			
Maternal-Reported			
Pressuring Feeding	0.47**	0.16	(0.15, 0.79)
Responsive Feeding	0.05	0.18	(−0.32, 0.41)
Observed			
Sensitivity to Infant Cues	−0.01	0.06	(−0.13, 0.11)
Response to Distress	0.06	0.06	(−0.06, 0.17)
Infant Characteristics			
Maternal-Reported			
Negativity	0.31**	0.09	(0.14, 0.48)
Surgency	−0.21*	0.09	(−0.38, −0.04)
Enjoyment of Food	0.14	0.15	(−0.16, 0.44)
Food Responsiveness	−0.06	0.12	(−0.29, 0.17)
Satiety Responsiveness	0.15	0.12	(−0.10, 0.39)
Observed			
Clarity of Cues	0.01	0.06	(−0.10, 0.11)
Responsiveness to Caregiver	−0.06	0.06	(−0.17, 0.05)
Covariates			
Study			
Study A (Ventura et al., 2021)			
Study B (Ventura, Levy, & Sheeper, 2019)	−0.13	0.33	(−0.77, 0.52)
Study C (Ventura & Golen, 2015)	−0.69*	0.33	(−1.33, −0.04)
Study D (Ventura & Hernandez, 2019)	−0.91***	0.23	(−1.36, −0.45)
Mom Age	−0.02	0.02	(−0.05, 0.02)
Pre-pregnancy BMI			
Not Overweight/Obese			
Overweight/Obese	−0.38*	0.16	(−0.69, −0.06)

BMI, Body Mass Index or a weight-to-height ratio using a person's mass in kilograms and height in centimeters (BMI = weight [kg]/height [m]2).

$R^2 = 0.40$, F = 4.52, p < .0001, n = 124 due to 1 dyad missing data on use of FTS, 1 dyad missing data for maternal-reported feeding practices, 3 dyads missing data for observed feeding practices, 1 dyad missing data for infant eating behaviors, and 4 dyads missing data for mothers' prepregnancy BMI.

*
p < .05

**
p < .01

***
p < .001.

Note: Preliminary analyses using stepwise regression was used to identify relevant covariates; mother's age, mother's pre-pregnancy BMI, and the categorical variable for study were all significantly related to FTS and therefore were included as covariates.