Knowledge and Use of Paced Bottle-Feeding Among Mothers of Young Infants

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ABSTRACT

Objective: To describe mothers' awareness and use of paced bottle-feeding (PBF) and to investigate whether the use of PBF was associated with maternal characteristics and infant feeding practices.

Methods: Cross-sectional, online survey. Participants were mothers of infants < 12 months of age (n = 197). Participants self-reported their awareness and use of PBF, demographic characteristics, and infant feeding practices.

Results: Of the 41% of participants who indicated they had or maybe had heard of PBF, 23% used PBF and 35% sometimes used PBF. Use of PBF was not associated with mother or infant characteristics. Participants who used PBF were significantly less likely to encourage their infant to finish the bottle (odds ratio, 0.04; 95% confidence interval, 0.01−0.79).

Conclusions and Implications: Paced bottle-feeding was associated with lower likelihood of one dimension of pressuring feeding practices, encouraging infant bottle-emptying. More research is needed to determine the effectiveness of PBF in promoting healthy feeding outcomes.

Key Words: paced bottle-feeding, bottle-feeding, responsive feeding, mothers, infants (*J Nutr Educ Behav.* 2023;000:1−7.)

INTRODUCTION

Bottle-feeding is ubiquitous in infant feeding, but many bottle-feeding families receive inadequate support for learning healthy bottle-feeding practices.[1] Data from the US illustrate almost half of infants are exclusively bottle-fed by 6 months of age, and many breastfed infants receive supplemental formula or bottle-feedings,[2] but a striking 20% of formula-feeding mothers reported they received no advice related to infant feeding from health care professionals compared with only 5% of breastfeeding mothers.[3] In addition, mothers perceive health professionals to be ill-prepared to help them with their formula- and bottle-feeding needs and reluctant to discuss formula- or bottle-feeding at the risk of compromising breastfeeding support.[3]

This lack of support for formula- and bottle-feeding families is concerning, given formula-feeding and bottle-feeding are associated with a greater risk for rapid infant weight gain.[4,5] Risk for rapid weight gain may be attributable to nutritional components of the formula, such as the higher protein and lower free-amino acid content relative to breast milk,[6,7] but may also be attributable to how infants are fed during bottle-feeding. Compared with breastfeeding mothers, bottle-feeding mothers are less likely to engage in responsive feeding, wherein the mother is responsive to infant hunger and satiation cues and allows those cues to guide the pace of feeding and the amount consumed.[8] Responsive feeding is hypothesized to support and promote infants' abilities to self-regulate intake in response to physiological needs (eg, hunger and satiation) through experiential learning. Caregivers' contingent responses to infants' behavioral cues during feeding help infants distinguish feelings of hunger and fullness from other needs (eg, sleepiness, distress) and learn appropriate responses.[9] Recent obesity prevention efforts illustrate that promoting parent responsiveness supports the development of healthy eating behaviors and weight gain trajectories during early childhood.[10,11] Instead, bottle-feeding mothers are more likely to use nonresponsive, pressuring or controlling feeding practices (eg, feeding to a schedule), associated with an increased risk for rapid weight gain.[5,12] Breastfeeding support is an important primary prevention strategy, but secondary prevention strategies are also needed to help formula-feeding and bottle-feeding families practice responsive bottle-feeding and to promote healthy weight gain trajectories for formula- and bottle-feeding infants.

Few studies examine secondary prevention strategies to promote healthy bottle-feeding, creating a significant research gap that hinders support for bottle-feeding families.

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Thus, promoting responsive bottle-feeding remains a realistic but underutilized facet of perinatal education and infant feeding support. One promising strategy is the paced bottle-feeding (PBF) method, which incorporates many concepts and strategies consistent with responsive feeding. A lactation consultant first introduced PBF to reduce nipple confusion and bottle preference among breastfeeding infants introduced to bottles.[13] To implement PBF, caregivers are taught to (1) initiate feeding when the infant shows hunger cues, (2) pace the feeding in response to infant cues, and (3) terminate the feeding when the infant shows satiation cues. Caregivers are instructed to hold the infant and bottle in a way that moderates milk flow and encourages the infant to engage in the feeding. Taken together, the steps of PBF aim to make the experience of bottle-feeding more equivalent to the experience of breastfeeding by slowing the pace of feeding and increasing the amount of effort infants expend during bottle-feeding. Proponents of PBF claim that it promotes balanced control between caregiver and infant because the infant can better set the pace of feeding and stop feeding when full, thereby reducing the infant's risk of spitting up and overfeeding.[13]

Since its introduction in 2002,[13] inclusion of education about PBF in infant feeding curricula has grown in popularity. Although teaching new parents PBF is promising, to our knowledge, it is not an evidence-based practice. A few studies have examined the benefits of paced feeding for preterm infants transitioning to independent oral feeding,[14−17] but no published empirical studies evaluate the use of PBF among families with bottle-feeding term infants. Thus, despite the conceptual promise of PBF for promoting responsive bottle-feeding, research is needed to determine whether PBF is effective and observe whether any limitations of the method exist. This study aimed to (1) explore how aware US mothers are of PBF and (2) explore whether the use of PBF was associated with maternal characteristics and maternal-reported feeding practices.

METHODS

Participants

Data collection occurred in January 2020. Mothers with infants were recruited through a Qualtrics survey panel (Qualtrics, version 2020, Provo, UT, USA) comprised of individuals residing throughout the U.S. who were assembled by Qualtrics to participate in various research studies. Thus, participants were recruited directly by Qualtrics as part of their survey panel service. Eligibility criteria were (1) aged ≥ 18 years, (2) living anywhere in the US, (3) mother to an infant born term (≥ 37 weeks gestation) that is currently aged ≤ 12 months. All study procedures were approved via expedited review by the California Polytechnic State University Institutional Review Board (protocol no. 2018-253-CP). All participants provided written consent for participation before completing the study questionnaires. Participants were compensated directly through the Qualtrics survey panel service and according to the panel's standard compensation options.

Measures

Participants completed questionnaires via Qualtrics' online survey platform. Measures are available on request.

Awareness of PBF and use of PBF

The research team developed 2 questions to assess participants' awareness and use of PBF. To assess awareness of PBF, participants were asked if they ever heard of the PBF technique (response options included: yes, maybe, or no). Participants who responded yes or maybe to the awareness question were asked if they use the PBF technique to feed their baby (response options included: yes, sometimes, or no).

Milk type, feeding mode, and feeding practices

Participants reported the type of milk their infant received (ie, milk type): breast milk only, formula only, or both. Participants reported their infant's feeding mode: directly from the breast, bottles, or both.

Participants also estimated the percentage of daily milk feedings (response range: 0% to 100%) that came from the breast vs bottles and that were breast milk vs formula. With respect to feeding practices, participants were asked, when deciding how often to feed their baby, do they usually (1) feed their baby on demand, (2) follow a routine, or (3) a combination of both. In addition, participants were asked how often their baby is encouraged to finish their bottle if they stop drinking before the milk is all gone (response options were based on a 5-point Likert scale ranging from never to always). Feeding practice questions came from the Infant Feeding Practices Survey II.[18]

Family demographics

Participants reported their age, parity, education level, employment status, annual family income level, participation in the *Special Supplemental Nutrition Program for Women, Infants, and Children* (WIC), marital status, ethnicity (response options: [1] Hispanic or Latinx and [2] non-Hispanic or non-Latinx), and race (response options: [1] White/Caucasian/European, [2] Black/African American, [3] American Indian or Alaskan Native, [4] Chinese, [5] Filipino, [6] Japanese, [7] Korean, [8] Vietnamese, [9] Native Hawaiian, [10] Guamanian or Chamorro, [11] Samoan, or [12] Other). For analysis, race and ethnicity were combined and collapsed into race/ethnicity categories that aligned with the US Census Bureau and US Office of Management and Budget guidelines: (1) Hispanic, (2) White alone, non-Hispanic, (3) Black or African American alone, non-Hispanic, (4) American Indian and Alaska Native alone, non-Hispanic, (5) Asian alone, non-Hispanic, (6) Native Hawaiian and Other Pacific Islander alone, non-Hispanic, (7) Other Race alone, non-Hispanic, or (8) multiracial, non-Hispanic.[19]

Maternal weight status

Participants reported their current weight and height, which were used to calculate body mass index (BMI) (kg/m^2).

Infant characteristics

Participants reported infant sex and age. Participants also reported their infants' weight and length at birth. Infant birth weight data were normalized to weight-for-age z-scores using the World Health Organization Anthro software (version 3.0.1) to calculate sex-specific z-scores.[20]

Quality control questions

Participants were asked 2 quality control questions. The first was a forced response question: "This question is a quality control test. Please select yes." The second open-ended question asked participants to provide an overview of their experience as a parent, including what they like best and least about parenting.

Data Analysis

A total of 210 respondents completed the survey. Participants were excluded for the following data quality concerns: nonsensical responses to quality control questions (n = 9), very low infant birth weight (< 5 pounds; n = 2), implausible BMI for the mother (n = 1), and very high infant birth weight (> 13 pounds; n = 1). Thus, the final sample included in the data analysis was 197.

All analyses were conducted using SAS software (version 9.4, SAS Institute Inc, 2013). Descriptive statistics were calculated to summarize mother and infant characteristics and feeding practices. General linear models for continuous response variables and chi-square test of homogeneity or Fisher exact tests for categorical response variables were used to examine associations between awareness and use of PBF and percent of daily feedings that were breast milk (vs formula), percent of daily feedings from the breast (vs from a bottle), and mother and infant characteristics. Within a subsample who (1) indicated they gave their infants bottles, (2) reported they were aware of paced bottle-feeding, and (3) provided a response to the question asking whether they used the PBF technique to feed their baby (n = 43), logistic regression was used to investigate whether the use of PBF predicted feeding practices (demand vs scheduled feeding and encouragement of infant bottle-emptying). Within these models, demand vs scheduled feeding was coded as a 2-level response variable (following a routine vs feeding on demand or a combination of both), and encouragement of infant bottle-emptying was also coded as a 2-level response variable (always or most of the time vs never, rarely, or sometimes). Because we were interested in examining whether PBF was associated with responsive feeding, we specified the less responsive options (ie, following a routine and always or most of the time, respectively) as the reference variables. The logistic regression models controlled for the percentage of daily feedings from a bottle, infant age at the time of the survey, race/ethnicity, income, and WIC participation. Statistical significance was defined as $P < 0.05$.

RESULTS

Sample Characteristics

Table 1 summarizes sample characteristics. The average age for mothers was 30.0 ± 5.9 years (range, 18−53 years). Thirty percent (n = 59) were primiparous, averaging 2.3 ± 1.3 (range, 0−8) children. Twenty-six percent (n = 52) reported they had a college or graduate degree, 61% (n = 120) were employed, and 26% (n = 52) reported their annual family income level was ≥ $75,000. Half (n = 99) participated in WIC. Approximately 16% (n = 31) identified as Hispanic, and 56% (n = 110) identified as White, non-Hispanic. Average maternal BMI was 27.7 ± 6.9 kg/m^2 (range, 14.6 −51.2); 61% (n = 119) had overweight or obesity (BMI ≥ 25 kg/m^2). With respect to infant characteristics, 56% (n = 110) were female, and the average age at the time the survey was completed was 4.1 ± 1.6 months (range, 0.15−10 months). Infant weight-for-age z-score at birth was −0.2 ± 1.3 (range, −4.4 to 4.4).

As illustrated in Table 1, 32.5% (n = 64) of participants reported they only breastfed from the breast, whereas 40.1% (n = 79) only used bottles and 27.4% (n = 54) did both. The average percentage of daily feedings that were formula (vs breast milk) was 44.1% ± 45.9% (range, 0% to 100%), and the average percentage of daily feedings that were from bottles (vs the breast) was 51.9% ± 44.3% (range, 0% to 100%). With respect to how mothers decided when and how much to feed their infant, 30.5% (n = 60) of participants indicated they fed their infant on demand (eg, in response to their baby's cues), 20.3% (n = 40) indicated they followed a schedule (eg, fed every 3 hours), and the remaining 49.2% (n = 97) indicated they did a combination of demand and scheduled feeding. Forty-three percent (n = 85) indicated that they encouraged their infant to finish the bottle most of the time or always.

Demographic Correlates of Awareness and Use of PBF

Most participants (59%, n = 117) indicated they had not heard of PBF (Table 1). Maternal employment was the only demographic characteristic associated with awareness of PBF; a significantly greater proportion of participants who indicated they were or maybe were aware of PBF were employed (74.8%, n = 59) compared with those who had not heard of PBF (52.6%, n = 61; $P < 0.001$).

As illustrated in Table 2, among partially or exclusively bottle-feeding participants who indicated they were aware of PBF and provided a response to the item on whether they used PBF technique to feed their baby (n = 43), 23.3% (n = 10) indicated they used PBF, 34.9% (n = 15) indicated they sometimes used PBF, and 41.9% (n = 18) indicated they did not use PBF. Reported use of PBF was not associated with mother or infant characteristics (Table 2).

Associations Between PBF and Feeding Practices

The use of PBF was not associated with participants' reports of feeding their infant on demand vs on a schedule (odds ratio, 1.60; 95% confidence interval, 0.16−16.36). Participants who used PBF were significantly less likely to encourage their infant to finish the bottle than those who did not use PBF (odds ratio, 0.04; 95% confidence interval, 0.01−0.79).

Table 1. Descriptive Characteristics of Study Sample and by Awareness of Paced Bottle-Feeding (PBF)

| | | Awareness of PBF | | |
Characteristics	Total Sample, n = 197	Yes/Maybe, n = 80	No, n = 117	P[a]
Mother characteristics				
Age, y	30.0 ± 5.9	29.4 ± 6.3	30.4 ± 5.5	0.20
Parity, % primiparous	59 (30.0)	24 (30.0)	35 (29.9)	0.13
Educational level				0.80
High school diploma or less	53 (26.9)	22 (27.5)	31 (26.5)	
Some college	91 (46.2)	35 (43.8)	56 (47.9)	
College degree	30 (15.2)	12 (15.0)	18 (15.4)	
Graduate degree	22 (11.2)	11 (13.8)	11 (9.4)	
Not reported	1 (0.5)	0 (0)	1 (0.9)	
Employed	120 (60.9)	59 (74.8)	61 (52.6)	< 0.001
Annual family income				0.15
< $25,000	33 (16.8)	11 (13.8)	22 (18.8)	
$25,000−$49,999	72 (36.6)	26 (32.5)	46 (39.3)	
$50,000−$74,999	38 (19.3)	14 (17.5)	24 (20.5)	
≥ $75,000	52 (26.4)	28 (35.0)	24 (20.5)	
Not reported	2 (1.0)	1 (1.3)	1 (0.9)	
Participation in WIC program	99 (50.3)	42 (52.5)	57 (48.7)	0.60
Marital status				0.88
In a relationship but not living with partner	13 (6.6)	6 (7.5)	7 (6.0)	
Living with, but not married to, partner	47 (23.9)	17 (21.3)	30 (25.6)	
Married to partner	106 (53.8)	44 (55.0)	62 (53.0)	
Single	30 (15.2)	13 (16.3)	17 (14.5)	
Not reported	1 (0.5)	0 (0)	1 (0.9)	
Race/ethnicity				0.37
Hispanic	31 (15.7)	17 (21.3)	14 (12.0)	
White alone, non-Hispanic	110 (55.8)	39 (48.8)	71 (60.7)	
Black or African American alone, non-Hispanic	29 (14.7)	12 (15.0)	17 (14.5)	
American Indian and Alaska Native alone, non-Hispanic	1 (0.5)	1 (1.3)	0 (0)	
Asian alone, non-Hispanic	11 (5.6)	4 (5.0)	7 (6.0)	
Native Hawaiian and Other Pacific Islanders alone, non-Hispanic	1 (0.5)	0 (0)	1 (0.9)	
Some Other Race alone, non-Hispanic	3 (1.5)	2 (2.5)	1 (0.9)	
Multiracial, non-Hispanic	10 (5.1)	5 (6.3)	5 (4.3)	
Not reported	1 (0.5)	0 (0)	1 (0.9)	
Body mass index, kg/m^2	27.7 ± 6.9	27.8 ± 6.7	27.7 ± 6.8	0.87
Infant characteristics				
Sex, female	110 (55.8)	43 (53.8)	67 (57.3)	0.62
Age, mo	4.1 ± 1.6	4.2 ± 1.8	3.9 ± 1.6	0.18
Weight-for-age z-score at birth	-0.2 ± 1.3	-0.2 ± 1.5	-0.1 ± 1.1	0.54
Infant feeding				
Milk type				0.11
Breast milk only	91 (46.2)	40 (50.0)	51 (43.6)	
Formula only	68 (34.5)	21 (26.3)	47 (40.2)	
Breast milk and formula	38 (19.3)	19 (23.8)	19 (16.2)	
Feeding mode				0.23
Only directly from the breast	64 (32.5)	31 (38.8)	33 (28.2)	
Only from bottles	79 (40.1)	27 (33.8)	52 (44.4)	
Both directly from the breast and from bottles	54 (27.4)	22 (27.5)	32 (27.4)	
Use of demand vs scheduled feedings				0.23
Demand feeding	60 (30.5)	23 (28.8)	37 (31.6)	
Scheduled feeding	40 (20.3)	21 (26.3)	19 (16.2)	
Combination of demand and scheduled feeding	97 (49.2)	36 (45.0)	61 (52.1)	
Maternal encouragement of bottle-emptying[b]				0.06
Sometimes, rarely, or never	112 (56.9)	39 (48.8)	73 (62.4)	
Most of the time or always	85 (43.2)	41 (51.3)	44 (37.6)	

PBF indicates paced bottle-feeding; WIC, *Special Supplemental Nutrition Program for Women, Infants, and Children*.
[a]For general linear models or chi-square tests of homogeneity comparing yes/maybe vs no awareness of PBF groups; [b]n = 133; does not include participants who indicated they only fed their infant directly from the breast.
Note: Values are presented as mean ± SD or n (%).

Table 2. Correlates of Use of Paced Bottle-Feeding (PBF) (n = 43)[a]

Characteristics	Use of PBF			P[b]
	Yes, n = 10	Sometimes, n = 15	No, n = 18	
Mother characteristics				
Age, y	31.0 ± 3.4	27.8 ± 7.2	29.6 ± 5.2	0.38
Parity, % primiparous	3 (30.0)	3 (20.0)	3 (16.7)	0.80
Educational level				0.87
High school diploma or less	2 (20.0)	5 (33.3)	7 (38.9)	
Some college	6 (60.0)	8 (53.3)	9 (50.0)	
College degree	0 (0)	0 (0)	0 (0)	
Graduate degree	2 (20.0)	2 (13.3)	2 (11.1)	
Employed	7 (80.0)	10 (66.7)	13 (72.2)	0.99
Annual family income				0.27
< $25,000	1 (10.0)	4 (26.7)	0 (0)	
$25,000-$49,999	4 (40.0)	6 (40.0)	8 (44.4)	
$50,000-$74,999	2 (20.0)	3 (20.0)	6 (33.3)	
≥ $75,000	3 (30.0)	1 (6.7)	4 (22.2)	
Not reported	0 (0)	1 (6.7)	0 (0)	
Participation in WIC program	8 (80.0)	8 (53.3)	11 (61.1)	0.40
Marital status				0.55
In a relationship but not living with a partner	0 (0)	2 (13.3)	2 (11.1)	
Living with, but not married to, partner	1 (10.0)	6 (40.0)	4 (22.2)	
Married to partner	6 (60.0)	5 (33.3)	9 (50.0)	
Single	3 (30.0)	2 (13.3)	3 (16.7)	
Race/ethnicity				0.95
Hispanic	1 (10.0)	2 (13.3)	4 (22.2)	
White alone, non-Hispanic	6 (60.0)	7 (46.7)	9 (50.0)	
Black or African American alone, non-Hispanic	2 (20.0)	1 (6.7)	2 (11.1)	
American Indian and Alaska Native alone, non-Hispanic	0 (0)	1 (6.7)	0 (0)	
Asian alone, non-Hispanic	0 (0)	0 (0)	1 (5.6)	
Native Hawaiian and Other Pacific Islander alone, non-Hispanic	0 (0)	0 (0)	0 (0)	
Some Other Race alone, non-Hispanic	0 (0)	1 (6.7)	1 (5.6)	
Multiracial, not Hispanic	1 (10.0)	3 (20.0)	1 (5.6)	
Body mass index, kg/m^2	29.2 ± 6.2	27.5 ± 6.5	30.0 ± 7.7	0.60
Infant characteristics				
Sex, female	5 (50.0)	7 (46.7)	7 (38.9)	0.86
Age, mo	3.7 ± 1.8	3.9 ± 1.4	4.1 ± 1.8	0.86
Weight-for-age z-score at birth	−0.8 ± 1.6	−0.2 ± 1.5	−0.1 ± 0.9	0.28
Milk type and feeding mode				
Milk type				0.70
Breast milk only	3 (30.0)	2 (13.3)	3 (16.7)	
Formula only	3 (30.0)	7 (46.7)	10 (55.6)	
Breast milk and formula	4 (40.0)	6 (40.0)	5 (27.8)	
Feeding mode				0.42
Only from bottles	5 (50.0)	8 (53.3)	13 (72.2)	
Both directly from the breast and from bottles	5 (50.0)	7 (46.7)	5 (27.8)	

PBF indicates paced bottle-feeding; WIC, *Special Supplemental Nutrition Program for Women, Infants, and Children.*
[a]Analyses limited to a subsample of participants who (1) were partially or exclusively bottle-feeding, (2) indicated they were aware of PBF, and (3) provided a response to the item assessing whether they used PBF when feeding their baby; [b]For general linear models or Fisher exact tests comparing yes vs sometimes vs no responses to use of PBF.
Note: Values are presented as mean ± SD or n (%).

DISCUSSION

This study aimed to examine the extent to which mothers of infants were aware of and used PBF and whether PBF was associated with maternal or infant characteristics and maternal-reported feeding practices. Approximately 41% of participants indicated they were aware of PBF, and 13% reported they used or sometimes used PBF when bottle-feeding their infant. The use of PBF was not associated with maternal or infant characteristics, such as

education level, participation in WIC, or race/ethnicity, but participants who used PBF were less likely to report encouraging their infant to finish the bottle compared with mothers who did not use PBF.

This study examined PBF among families with infants born term and without significant feeding issues. A small body of literature examines how PBF may support the transition to independent feeding for premature infants. These studies show that teaching neonatal intensive care unit nurses to use PBF with premature infants leads to fewer bradycardic incidences during feeding and supports the development of more efficient sucking patterns than traditional bottle-feeding.[14,15] Using bottles that better facilitated premature infants' abilities to self-pace feeding led to shorter feeding durations and greater feeding efficiency than traditional bottles.[16,17] Beyond these studies of premature infants, much of the available literature on PBF comes from educational materials produced by clinicians, formula or bottle producers, and public health programs.

Current infant feeding guidelines recommend that caregivers practice responsive feeding regardless of whether they are breastfeeding or bottle-feeding,[11,21] and, although PBF is a distinct concept from responsive feeding, it is complementary in that it emphasizes demand feeding, or feeding in response to infant hunger and fullness cues. Within this study, we noted that only 31% of mothers reported they fed their infants on demand, 20% reported following a schedule, and 49% did both. In addition, almost 50% reported they frequently encouraged their infant to finish the bottle. Previous research links feeding to a schedule with an increased risk for rapid infant weight gain.[5] Findings for encouragement to finish the bottle are equivocal, with some studies suggesting that caregivers adopt this practice in response to lower infant birth weight or slower infant weight gain[22–24] but also contingent on increases in the amount of bottle-feeding they are doing.[24] Previous research also suggests mothers are more likely to encourage bottle-emptying when bottle-feeding expressed breast milk compared with formula.[24]

Longitudinal research illustrates that, over time, frequent encouragement of bottle-emptying during infancy predicts lower satiety responsiveness during early childhood.[25] These findings suggest that many families need additional support to understand the value of infant-led, responsive feeding styles, and the potential benefits of refraining from pressuring feeding practices, such as encouraging infant bottle-emptying.

A key finding of this study was that using PBF was associated with a significantly lower likelihood of encouraging infant bottle-emptying. However, these data were cross-sectional, from a small sample size, and mother-reported, which limits generalizability and precludes abilities to determine the mechanisms underlying this association. One possible interpretation of this association is that PBF promotes infant-led feeding, thereby reducing mothers' use of pressuring feeding practices, such as encouraging their infant to finish the bottle. Conversely, it is also possible that mothers who already adhere to less pressuring and more responsive feeding practices and styles are also more willing to use PBF. Thus, further experimental and longitudinal research is warranted to understand better whether educating caregivers about PBF promotes responsive feeding and reduces the use of pressuring feeding practices.

Most mothers reported they had not heard of PBF, and a significant proportion of those that had heard of PBF did not use it. We did not find associations between awareness or use of PBF and most maternal or infant characteristics, suggesting PBF is not limited to certain demographic groups. However, we did see that participants who were aware of PBF were more likely to be employed. This finding may be because PBF was originally proposed as a method for introducing bottles to the breastfed infant[13]; thus, participants returning to work may have been more likely to seek bottle-feeding advice or resources to prepare for this transition. Further mixed-methods research is needed to understand when caregivers learn about PBF or other bottle-feeding practices and the motivations for vs against using the learned practices.

Limitations of this study highlight opportunities for future research. This study was cross-sectional; thus, it was not possible to determine the direction of effects for noted associations. In addition, although the sample was recruited from across the US and was representative regarding race/ethnicity, income, education levels, and WIC participation, the relatively small number of participants who used PBF may limit the generalizability of our logistic regression findings. Further research is needed to examine whether study findings are replicated in larger, more diverse, and focused samples of bottle-feeding families. Although we recruited mothers of infants for this study, we did not explicitly ask participants to report their sex or gender. This study also relied on maternal reports; mothers' perceptions of their previous education or feeding practices may have been susceptible to recall or social desirability biases. For example, mothers indicated they might have heard of PBF to avoid admitting they were uninformed. In addition, the questions regarding mothers' awareness and use of PBF were not validated, which may have led to further bias in the measurement of awareness and use of PBF, given it is unclear as to whether all participants understood and interpreted these questions and the concept of PBF in the same way. It is also possible that different educators or practitioners use different labels for PBF, leading to an underestimation of the number of participants who had heard of or used PBF. Additional longitudinal or experimental research that includes validated questionnaires assessing PBF or objective measures of mothers' feeding practices and infants' feeding outcomes is needed to further understand associations between PBF, feeding practices, and feeding outcomes.

IMPLICATIONS FOR RESEARCH AND PRACTICE

Educational materials from various sources communicate the PBF approach and potential benefits, suggesting that caregivers want support for healthy bottle-feeding and that many educators and clinicians are

willing to provide that support. However, there is currently a lack of research examining the purported benefits of PBF, meaning that teaching parents about PBF is not currently an evidence-based practice. Further research is needed to support clinical practice by examining whether PBF supports healthy feeding and weight outcomes for infants. In addition, we noted that many of the mothers who participated in this study reported using bottle-feeding practices that were not aligned with current feeding guidelines. Thus, findings from the present study suggest bottle-feeding families may need additional tailored support to practice responsive feeding during bottle-feeding interactions and meet their infant feeding needs.

REFERENCES

1. Lakshman R, Ogilvie D, Ong KK. Mothers' experiences of bottle-feeding: a systematic review of qualitative and quantitative studies. *Arch Dis Child.* 2009;94:596–601.
2. Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion. Breastfeeding Report Card. United States, 2022. https://www.cdc.gov/breastfeeding/data/reportcard.htm. Accessed May 26, 2023.
3. Appleton J, Laws R, Russell CG, Fowler C, Campbell KJ, Denney-Wilson E. Infant formula feeding practices and the role of advice and support: an exploratory qualitative study. *BMC Pediatr.* 2018;18:12.
4. Li R, Magadia J, Fein SB, Grummer-Strawn LM. Risk of bottle-feeding for rapid weight gain during the first year of life. *Arch Pediatr Adolesc Med.* 2012;166:431–436.
5. Mihrshahi S, Battistutta D, Magarey A, Daniels LA. Determinants of rapid weight gain during infancy: baseline results from the NOURISH randomised controlled trial. *BMC Pediatr.* 2011;11:99.
6. Mennella JA, Ventura AK, Beauchamp GK. Differential growth patterns among healthy infants fed protein hydrolysate or cow-milk formulas. *Pediatrics.* 2011;127:110–118.
7. Koletzko B, von Kries R, Closa R, et al. Lower protein in infant formula is associated with lower weight up to age 2 y: a randomized clinical trial. *Am J Clin Nutr.* 2009;89:1836–1845.
8. Ventura AK. Associations between breastfeeding and maternal responsiveness: a systematic review of the literature. *Adv Nutr.* 2017;8:495–510.
9. DiSantis KI, Hodges EA, Johnson SL, Fisher JO. The role of responsive feeding in overweight during infancy and toddlerhood: a systematic review. *Int J Obes (Lond).* 2011;35:480–492.
10. Savage JS, Birch LL, Marini M, Anzman-Frasca S, Paul IM. Effect of the Insight responsive parenting intervention on rapid infant weight gain and overweight status at age 1 year: a randomized clinical trial. *JAMA Pediatr.* 2016;170:742–749.
11. Pérez-Escamilla R, Segura-Pérez S, Lott M. *Feeding Patterns, and Weight Status for Infants and Toddlers From Birth to 24 Months. Feeding Guidelines for Infants and Young Toddlers: A Responsive Parenting Approach.* Healthy Eating Research; 2017.
12. Appleton J, Russell CG, Laws R, Fowler C, Campbell K, Denney-Wilson E. Infant formula feeding practices associated with rapid weight gain: a systematic review. *Matern Child Nutr.* 2018;14:e12602.
13. Kassing D. Bottle-feeding as a tool to reinforce breastfeeding. *J Hum Lact.* 2002;18:56–60.
14. Law-Morstatt L, Judd DM, Snyder P, Baier RJ, Dhanireddy R. Pacing as a treatment technique for transitional sucking patterns. *J Perinatol.* 2003;23:483–488.
15. Howe TH, Sheu CF, Hinojosa J, Lin J, Holzman IR. Multiple factors related to bottle-feeding performance in preterm infants. *Nurs Res.* 2007;56:307–311.
16. Lau C, Schanler RJ. Oral feeding in premature infants: advantage of a self-paced milk flow. *Acta Paediatr.* 2000;89:453–459.
17. Lau C, Fucile S, Schanler RJ. A self-paced oral feeding system that enhances preterm infants' oral feeding skills. *J Neonatal Nurs.* 2015;21:121–126.
18. Fein SB, Labiner-Wolfe J, Shealy KR, Li R, Chen J, Grummer-Strawn LM. Infant Feeding Practices Study II: study methods. *Pediatrics.* 2008;122(suppl 2):S28–S35.
19. Jensen E, Jones N, Orozco K, et al. Measuring racial and ethnic diversity for the 2020 Census. US Census Bureau. https://www.census.gov/newsroom/blogs/random-samplings/2021/08/measuring-racial-ethnic-diversity-2020-census.html. Accessed Jul 20, 2023.
20. World Health Organization. Child growth standards. https://www.who.int/tools/child-growth-standards/software. Accessed Jul 20, 2023.
21. US Department of Agriculture. *Dietary Guidelines for Americans: 2020−2025.* https://www.dietaryguidelines.gov/sites/default/files/2021-03/Dietary_Guidelines_for_Americans-2020-2025.pdf. Accessed May 26, 2023.
22. Li R, Fein SB, Grummer-Strawn LM. Association of breastfeeding intensity and bottle-emptying behaviors at early infancy with infants' risk for excess weight at late infancy. *Pediatrics.* 2008;122(suppl 2):S77–S84.
23. Ventura AK, Thompson K. Predictors of resilience among infants at risk for rapid weight gain. *Obesity (Silver Spring).* 2019;27:130–136.
24. Ventura AK, Garcia P, Schaffner AA. Associations between bottle-feeding intensity and maternal encouragement of bottle-emptying. *Public Health Nutr.* 2017;20:3090–3098.
25. Li R, Scanlon KS, May A, Rose C, Birch L. Bottle-feeding practices during early infancy and eating behaviors at 6 years of age. *Pediatrics.* 2014;134(suppl 1):S70–S77.

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