



Promoting Responsive Bottle-Feeding Within WIC: Evaluation of a Policy, Systems, and Environmental Change Approach



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ABSTRACT

Background Bottle-fed infants are at greater risk for overfeeding and rapid weight gain (RWG); evidence-based strategies for promoting healthy bottle-feeding practices are needed. **Objective** Our aim was to assess whether policy, systems, and environmental (PSE) strategies for promoting responsive bottle-feeding practices within the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) were associated with lower risk for RWG.

Design We conducted a matched-pair cluster randomized trial. PSE strategies were implemented at 3 WIC clinics in Los Angeles County. PSE clinics were compared with 3 matched control clinics. Mothers and infants were assessed when infants were newborn and 3 months and 6 months of age.

Participants/setting Participants were mothers ($n = 246$) who enrolled their newborn infants (younger than 60 days) into WIC between May and August 2019.

Main outcome measures Infant weight was assessed and standardized to sex- and age-specific z scores. RWG was defined as weight-for-age z score change > 0.67 . Mothers completed questionnaires assessing responsive and pressuring feeding styles, breast- and bottle-feeding patterns, and perceptions of WIC experiences.

Statistical analyses performed Logistic regression with estimation via generalized estimating equations and linear mixed models with repeated measures assessed effects of PSE strategies on categorical and continuous outcomes, respectively.

Results Infants in PSE clinics had significantly lower likelihood of exhibiting RWG ($P = .014$) than infants in control clinics. Mothers in PSE and control clinics reported similar levels of responsive and pressuring feeding style and similar prevalence of breastfeeding and bottle-feeding. Mothers in PSE clinics trended toward feeling better supported with respect to their decision to bottle-feed ($P = .098$) and had more stable intentions to stay in the WIC program ($P = .002$) compared with mothers in control clinics.

Conclusions PSE strategies focused on promoting more inclusive assessment of infant feeding, tailored bottle-feeding counseling, and increased education and support for responsive bottle-feeding were associated with lower risk for RWG among WIC infants. *J Acad Nutr Diet.* 2022;122(1):99-109.

OBESITY DURING CHILDHOOD IS ONE OF THE strongest predictors of obesity and metabolic comorbidities during adolescence and later adulthood.^{1,2} Rapid weight gain (RWG) during infancy is a known risk factor for obesity.^{3,4} Evidence-based strategies for

preventing RWG during infancy are a potential key pathway to prevention of early childhood obesity and later comorbidities.

An important target for early prevention efforts is the promotion of responsive feeding styles during infancy,⁵⁻⁸ defined as caregivers' adoption of feeding attitudes and practices that are responsive to children's satiety cues and developmental needs.^{9,10} Studies of feeding styles and practices during the infant and toddler years suggest that caregivers' adherence to responsive feeding styles and use of responsive feeding practices are associated with lower risk for RWG and later childhood obesity for children.⁹⁻¹⁵ Responsive feeding and parenting during infancy are also associated with various positive behavioral outcomes during later childhood, such as more consistent feeding routines and lower likelihood of pressuring children to eat or using food to soothe a fussy child.¹⁵⁻¹⁷

The Continuing Professional Education (CPE) quiz for this article is available for free to Academy members through the MyCDRGo app (available for iOS and Android devices) and through www.jandonline.org (click on "CPE" in the menu and then "Academy Journal CPE Articles"). Log in with your Academy of Nutrition and Dietetics or Commission on Dietetic Registration username and password, click "Journal Article Quiz" on the next page, then click the "Additional Journal CPE quizzes" button to view a list of available quizzes. Non-members may take CPE quizzes by sending a request to journal@eatright.org. There is a \$45 fee per quiz (includes quiz and copy of article) for non-members. CPE quizzes are valid for 3 years after the issue date in which the articles are published.

Although responsive feeding is possible during both breast- and bottle-feeding, and can be promoted through targeted interventions,¹⁸ previous research suggests bottle-feeding is associated with greater adherence to pressuring feeding styles, greater use of pressuring feeding practices (eg, encouraging the infant to finish the bottle) that lead to overfeeding, and greater risk for RWG and later obesity.¹⁸⁻²² This risk may be attributable, in part, to the fact that bottle-feeding affords the caregiver more opportunities to control what and how much is in the bottle, as well as greater abilities to use pressuring feeding practices, such as encouraging the infant to finish the bottle.²³ In addition, experimental research suggests some mothers may be less sensitive to their infant's cues during bottle-feeding due to the potent bottle-based cues (ie, the amount of formula left in the bottle) afforded by conventional clear bottles.^{23,24} This may lead to overfeeding for certain infants, such as those who exhibit lower clarity of cues.^{23,25} In contrast, breastfeeding holds the potential for a better balance of control between mother and infant and, therefore, better supports infants' intake regulation.²⁶ Taken together, these findings suggest empowering bottle-feeding caregivers to establish responsive feeding styles and practices during infancy may reduce risk for overfeeding and RWG.

In 2018, the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) served approximately 6.4 million participants in the United States, making it a particularly relevant venue for early prevention efforts.²⁷ The WIC program is a US Department of Agriculture–funded food and nutrition education program serving low-income pregnant, breastfeeding, and postpartum women, infants, and children younger than 5 years who may be at nutritional risk. WIC helps families by providing healthy foods, nutrition education, and referrals to health care and other community services. In particular, a primary focus of the WIC program is to promote breastfeeding. WIC provides excellent resources for breastfeeding mothers, such as breastfeeding education, access to lactation consultants and peer counselors, and a breastfeeding warm-line; these efforts have successfully increased breastfeeding rates in the WIC population.²⁸⁻³⁰ In addition, many WIC programs already teach mothers about responsive feeding within a well-developed curriculum focused on infant cues and development;³¹ thus, this curriculum provides an effective foundation for further work to tailor and contextualize these messages for bottle-feeding interactions.

As a possible additional benefit of breastfeeding-promotion efforts within WIC, recent research illustrates breastfeeding mothers are more likely to recertify their infant into WIC by age 14 months and stay in the WIC program longer than formula-feeding mothers.^{32,33} Previous focus group findings suggest these differences in retention in the WIC program may be underlined by differences in WIC experiences: formula-feeding mothers report feelings of judgment for not breastfeeding and feel less supported by WIC than breastfeeding mothers.³⁴ Taken together, interventions that support bottle-feeding mothers within WIC are needed to reduce risk for overfeeding and rapid weight, but may offer the additional benefit of helping formula-feeding mothers feel better supported by WIC.

These previous findings suggest that adaptations to WIC program activities may enhance support for all women by ensuring that WIC assessments allow for early identification of feeding styles and practices that can lead to overfeeding and WIC staff have the training and resources needed to effectively

RESEARCH SNAPSHOT

Research Question: Are policy, systems, and environmental (PSE) strategies for promoting responsive bottle-feeding practices within the Special Supplemental Nutrition Program for Women, Infants, and Children associated with lower risk for rapid infant weight gain?

Key Findings: Infants in Special Supplemental Nutrition Program for Women, Infants, and Children clinics wherein PSE strategies were implemented had 64% lower likelihood of exhibiting rapid weight gain compared with infants in control clinics. Prevalence of exclusive and any breastfeeding was similar for mothers in the PSE and control clinics, suggesting the PSE strategies did not negatively affect breastfeeding support.

translate existing responsive feeding messaging to bottle-feeding contexts. Although previous obesity prevention efforts have primarily focused on individual-level health risk behavior change, WIC clinics provide an excellent setting for implementation and evaluation of policy, systems, and environmental change (PSE) strategies, which are desirable because they hold the potential for a broader reach and greater sustainability compared with individual-level behavior change strategies.³⁵⁻³⁷ Use of PSE strategies are also highly consistent with WIC's focus on Value Enhanced Nutrition Assessment, a participant-centered, health outcome-based approach to WIC nutrition assessment that is a required and essential part of the WIC Program.³⁸ Effective PSE strategies have the additional benefit of promoting cultural change within an institution or community that can lead to more inclusive practices that provide better support to high-risk groups.^{36,37}

To this end, the aim of the present study was to assess whether PSE strategies for promoting responsive bottle-feeding styles and practices implemented within a large local agency WIC program were associated with lower risk for RWG. Study hypotheses were 3-fold. First, it was hypothesized that infants in clinics wherein the PSE strategies were implemented (hereafter referred to as PSE clinics) would have significantly lower odds of RWG between 0 and 6 months compared with infants in control clinics. Second, it was hypothesized that mothers in PSE clinics would report greater levels of responsive feeding style and more desirable infant feeding patterns (eg, less overfeeding of formula) than mothers in control clinics. Third, it was hypothesized that implementation of PSE strategies to promote responsive bottle-feeding would not significantly increase prevalence of bottle-feeding or decrease prevalence of breastfeeding among mothers in PSE clinics compared with mothers in control clinics. An exploratory aim was to examine whether mothers in PSE clinics felt more supported by WIC and greater desire to remain in the WIC program compared to control mothers.

METHODS

Description of the PSE Strategies

This study was conducted within the Public Health Foundation Enterprise (PHFE) WIC program, the largest local agency WIC program in the country, located in Southern California. The investigative team developed the following

PSE strategies based on the team's collective clinical and research expertise and experience. In addition, these strategies were built on the principles of Value Enhanced Nutrition Assessment.³⁸

PSE Strategy #1: More Inclusive Assessment of Early Infant Feeding Decisions as a Foundation for Tailored Intervention. According to an August 2018 report, 49% of all infants are enrolled in PHFE WIC in the first 7 days postpartum, and 88% are enrolled in their first month, offering the opportunity for WIC staff to support infant feeding decisions from very early postpartum (PHFE WIC, unpublished administrative data). To issue the proper WIC food package to the new mother–infant dyad, existing practice included an assessment of the mother's feeding practices, with a focus on how much breastfeeding was taking place. As follows, this assessment provided WIC staff with a robust basis for providing tailored and timely breastfeeding support (the assessment form was, in fact, titled the “breastfeeding assessment”), but had substantial room for improvement in assessing bottle-feeding in a way that would facilitate WIC staff's abilities to provide tailored, early intervention to promote healthy bottle-feeding practices. Thus, the first PSE strategy included renaming and retooling this assessment as an “infant feeding assessment” and updating WIC practice to better assess all feeding modes, with the ultimate goal of facilitating provision of targeted intervention that better suits the unique needs of breastfeeding and bottle-feeding mothers.

To accomplish this improved tailoring of the infant feeding assessment, the revised assessment started with a neutral question about the infant's feeding mode: “There are lots of ways you may be feeding your baby. How are you feeding your baby now?” Four possible answer choices included breastfeeding only from the breast, breastfeeding and pumping breastmilk, breastfeeding and formula-feeding, or formula-feeding only. Specific assessment tools were developed and tailored to each of these options so that WIC staff could continue to support the breastfeeding mother, but could also provide optimal support to bottle-feeding mothers, including mothers bottle-feeding breastmilk. In addition to the creation of multiple assessment tools that were designed to better align with the variety of feeding situations, each tool was revised to incorporate counseling probes and resources that staff could immediately use. For example, next to the question “how confident are you in knowing how much to feed your baby?,” the prompt “tell me more about that” was written to remind staff how to optimally follow-up with mothers who expressed a lack of confidence. Next to the prompt, a specific resource (eg, written handout or brochure) was listed so that staff could review the resource with the mother and give it to her to take home. These revisions align with Value Enhanced Nutrition Assessment guidance for developing effective assessment tools, which highlights the importance of considering impacts of question order, incorporating additional probing, using questions to draw out internal motivation and values, and affording the assessor flexibility in phrasing.³⁸ All assessment tools were developed in close partnership with the director of breastfeeding services and tested by multiple nutritionists before adoption. The assessment tool is available by request to the corresponding author.

PSE Strategy #2: Enhancing WIC Resources to Support Optimal Infant Feeding, Including Healthy Bottle-Feeding, Throughout the First Year of Life. Several high-quality resources were already in place to support breastfeeding mothers, including peer counselors and breastfeeding clinics in many sites, a breastfeeding support warm-line, online breastfeeding education, and interactive texting with other breastfeeding mothers. With fewer than half of WIC mothers doing any breastfeeding at 3 months and one-third doing any breastfeeding at 6 months, these resources, although critical for supporting breastfeeding, excluded the majority of WIC mothers. Thus, the second PSE strategy expanded use of one-on-one education, online education modules, and interactive texting to develop messaging inclusive of bottle-feeding strategies and directed at bottle-feeding mothers (eg, strategies for responsive bottle-feeding, guidance on paced bottle-feeding).

Materials for one-on-one education that were developed to facilitate staff discussions about bottle-feeding included a laminated 1-page tool titled “Let's Talk About Responsive Bottle-Feeding.” This tool included a picture of a WIC mother bottle-feeding her infant in a way that visually demonstrated responsive bottle-feeding. Under the picture was a brief description of responsive feeding, with a question at the bottom: “What do you notice about how this mother is feeding her baby?” On the back were counseling tips for the WIC staff (“AFFIRM what you hear from the mother,” “SHARE the following details about responsive feeding,” “ASK the mother what questions she has”). The breastfeeding support warm-line was also rebranded as “the infant feeding warm-line” and advertised to all women in need of feeding support. Finally, the interactive texting portal was enhanced to include periodic texts to mothers in PSE clinics to encourage responsive bottle-feeding. An example of some of the educational messages texted to mothers can be accessed at: <https://healthykids.calpoly.edu/WICExampleMaterials>. All materials are available by request to the corresponding author.

Study Design

This study was a matched-pair cluster randomized trial. Clinics within the PHFE WIC program were pair-matched on several criteria (race/ethnicity, clinic size, breastfeeding prevalence). Three matched pairs of clinics were then purposefully selected to maximize geographical distance between clinics (to reduce the possibility of contamination) then clinics within each pair were randomized to be either PSE or control clinics.

In May 2019, staff at PSE clinics were trained by the investigative team during a 1-day workshop. The training focused on conveying the rationale for promoting responsive bottle-feeding among WIC participants, introducing WIC staff to the new infant feeding assessment and resources to support optimal bottle-feeding, and providing WIC staff with opportunities to practice using the new infant feeding assessment. After the training, WIC staff at PSE clinics were then asked to apply the PSE strategies universally to all caregivers with newborns and young infants and were observed conducting the PSE strategies in the first month to promote fidelity. To further promote fidelity, the

investigative team provided ongoing support to the WIC staff through monthly clinic visits to the 3 PSE clinics to meet with staff at each center and review their use of the PSE strategies.

After staff training, PSE strategies were implemented at the PSE clinics in May 2019; no changes were made to WIC policies or practices at the control clinics. Between May and August 2019, baseline data collection occurred in-person at the PSE and control clinics at newborns' enrollment into the WIC program (typically within the first 14 days postpartum). Follow-up assessments occurred when infants were 3 months (between August and November 2019) and 6 months (October 2019 to February 2020) of age. A final assessment occurred when infants were 11 months of age, but the assessment window opened soon after PHFE WIC clinics transitioned to fully remote operations in response to the coronavirus disease 2019 (COVID-19) pandemic (April 2020). Although mothers still completed these final assessments, objective data on infant weight could not be collected and numerous aspects of the WIC experience were significantly altered. Given the possibility that the COVID-19 pandemic affected outcomes of interest, evaluation of effects was limited to the newborn, 3-month, and 6-month assessments. Retention rates through 6 months were high; 223 of 246 mothers participated at 3 months and 229 of 246 at 6 months.

Participants

A priori power analyses indicated that sample size of 100 per group would be sufficient to detect significant differences at power of .80 and $\alpha = .05$.^{39,40} Based on previous experience, it was expected that 15% to 20% of the sample would be lost to attrition. Thus, a sample of 246 mother–infant dyads were recruited; 124 dyads were recruited from the 3 PSE clinics (approximately 40 per site) and a comparable sample of 122 dyads were recruited from 3 control clinics (approximately 40 per site).

Mothers in both PSE and control clinics were recruited in person by WIC staff during their newborn enrollment into the WIC program from May to August 2019. During recruitment, mothers were told the purpose of the study was to learn “about how WIC can support new moms during infant feeding.” Eligibility criteria included mothers 18 years and older enrolling a newborn, singleton infant younger than 60 days and born at full-term. Both English- and Spanish-speaking mothers were included. Exclusion criteria included caregivers to foster children and children who were born preterm or who experienced growth faltering. This study was reviewed and approved by the California State Committee for Protection of Human Subjects (<https://oshpd.ca.gov/data-and-reports/data-resources/cphs/>); protocol #: 2019-044-PHFE WIC).

Measures

All assessments were available in English and Spanish. At the newborn assessment, mothers completed all questionnaires during their clinic visit. At the 3-month and 6-month assessments, mothers completed questionnaires remotely via an online survey platform (Qualtrics). Measures are available upon request and described in the following sections.

Infant Weight, Weight-for-Age z Scores, and RWG. Mothers reported infant birth weight. At the newborn assessment, trained WIC staff measured infant weight using a portable digital infant scale that was calibrated regularly (Seca 334; Seca Deutschland). Infants were weighed while wearing only a clean diaper. Subsequent infant weight was assessed using these methods any time the infant visited the WIC clinic for infant follow-up and postpartum appointments; measured weights were extracted from WIC electronic records for this study. The World Health Organization Anthro software,⁴¹ version 3.0.1, was used to calculate age- and sex-specific z scores and percentiles based on the World Health Organization growth standards. The majority of infants included in the present study had data on birth weight (220 of 246). At least 1 other weight measurement between 3 and 6 months of age was available for 192 infants; the timing of these measurements varied from infant to infant based on when they were present for their infant follow-up appointments. To maximize available data, change in weight-for-age z score (WAZ) between birth and the last weight assessment between 3 and 6 months of age was calculated for the 192 infants who had both birth weight and at least 1 subsequent weight measure. Then, RWG was defined as WAZ change >0.67 .³ To account for the possibility that change in WAZ, and, thus, prevalence of RWG, differed based on the age of the infant at the time of the last weight assessment, the time interval considered for each infant's change in WAZ (hereafter referred to as age at last WAZ measure) was included as a covariate in all analyses.

Infant Feeding Styles. At all assessments, mothers completed the responsive and pressuring feeding styles subscales of the Infant Feeding Styles Questionnaire, a questionnaire that assesses maternal behaviors and beliefs related to infant feeding.⁹ The responsive feeding style subscale assessed the extent to which the mother used feeding practices and held feeding beliefs that were infant-led and responsive to infant cues (example item: “I let my child decide how much to eat”). The pressuring feeding style subscale assessed the extent to which the mother used feeding practices and held feeding beliefs that encouraged infant consumption irrespective of hunger and satiation cues (example item: “I try to get my infant to eat even if s/he seems not hungry”). These 2 subscales were selected because they best aligned with the foci of the PSE strategies (ie, promoting adherence to responsive feeding styles and reducing use of pressuring feeding practices that promote overfeeding); thus, these subscales provided an assessment of changes in feeding styles targeted by the PSE strategies. Subscale scores range from 1 to 5, with higher scores representing more responsive or pressuring feeding styles. This scale has been validated in diverse samples of low-income mothers with young infants and subscales demonstrated acceptable internal reliability ($\alpha = .60$ to $.75$).⁹

Encouragement of Bottle-Emptying. As an additional measure of pressuring feeding practices, mothers also indicated how frequently they encouraged their infant to finish the bottle via 2 items that were adapted from the Infant Feeding Practices Study II⁴²: “I encourage my infant to finish his or her bottle of formula” and “I encourage my infant to finish his or her bottle of expressed breast milk.” Mothers

who were exclusively formula-feeding answered the first question only and mothers who were exclusively breast milk-feeding answered the second question only. Mothers who were feeding a mix of formula and breast milk answered both questions and responses were averaged. Similar to previous research,¹⁹ mothers' responses to these questions were included in analytical models as a single response reflecting the extent to which the mother encouraged her infant to finish his or her bottle of formula or expressed breast milk.

Introduction of Complementary Foods and Beverages. At 3 and 6 months, mothers were asked whether they had introduced complementary foods and beverages to their infant and, if so, the age at which complementary foods and beverages were introduced, as well as the frequency to which the mother added cereal to her infants' bottles, via items adapted from the Infant Feeding Practices Study II.⁴²

Breast and Bottle-Feeding. At all assessments, mothers reported whether they were exclusively breastfeeding their infants, feeding their infants a combination of breast milk and formula (any breastfeeding) or exclusively formula-feeding their infants. Mothers also estimated the percentage of daily milk feedings (response range, 0 to 100%) that came from bottles vs the breast, defined herein as feeding directly from the breast.

Perceptions of WIC Experiences. At the 3- and 6-month assessments, mothers responded to 6 items that were developed by the research team to assess perceptions of WIC and their WIC experiences. First, mothers were asked to indicate the extent to which they agreed with the statements "WIC supports my decision to breastfeed" and "WIC supports my decision to bottle-feed," with response options ranging from 1 (never) to 5 (always). Mothers were asked to indicate the extent to which they agreed with 2 statements assessing their experiences with WIC: "I am satisfied with my experience with WIC" and "My experiences at WIC have made me want to continue coming to WIC"; with response options ranging from 1 (never) to 5 (always). Mothers who were feeding their infant formula, either exclusively or in combination with breast milk, were asked to indicate the extent to which they agreed with the following statement: "I plan to keep coming to WIC even after the formula benefits end," with response options ranging from 1 (definitely no) to 3 (I don't know) to 5 (definitely yes). All mothers were asked "How long do you think you will keep coming to WIC?" with response options ranging from 1 (until my infant reaches 1 year of age) to 5 (until my infant reaches 5 years of age).

Family Demographics. Family demographics were assessed at baseline. Mothers reported their age, education level, parity, family income level, race and ethnicity, and preferred language.

Statistical Analysis

All analyses were conducted using SAS, version 9.4.⁴³ Data were thoroughly cleaned and tested for normality before analysis. Because randomization occurred on a clinic-by-clinic basis, yet measures were taken on individual participants, hierarchical models were necessary to account for the correlated nature of the repeated measures and clustering of

participants within sites.^{44,45} Thus, categorical outcome data were analyzed using logistic regression with estimation via generalized estimating equations (SAS PROC GLIMMIX) and continuous outcome data were analyzed using linear mixed models with repeated measures (SAS PROC MIXED). The within-subject, fixed factor was intervention vs control status; participant and clinic were treated as random effects. A strength of these approaches is that they allow for estimation of models with missing response data using maximum likelihood estimation under a missing at random assumption.⁴⁵

To test randomization success, baseline characteristics of participants who completed the study were compared and summarized. To examine impacts of the PSE strategies on infants' risk for RWG, logistic regression with estimation via generalized estimating equations was used to assess differences between PSE vs control clinics for risk of RWG. To examine impacts of the PSE strategies on prevalence of bottle-feeding and breastfeeding, responsive feeding style, pressuring feeding style, encouragement of infant bottle-emptying, and infant feeding patterns, linear mixed effects models were used to assess effects of time (indicative of significant change between the newborn enrollment, 3-month, and 6-month assessments), effects of the PSE strategies (indicative of significant differences between the PSE vs control clinics), and time \times PSE strategies interaction effects (indicative of significant differences between the PSE and control clinics for the amount of change that occurred over time). Finally, to assess impacts of the PSE strategies on mothers' perceptions of, and experiences with, WIC, linear mixed effects models were used to assess effects of time, PSE strategies, and time \times PSE strategies interaction effects. All models were controlled for maternal education, family income, parity, and percentage of daily feedings that came from a bottle. Given associations between infant weight outcomes and feeding practices, such as timing of introduction of complementary foods and beverages and adding cereal to the bottle,⁴⁶ models predicting RWG also controlled for these 2 variables. Preliminary analyses revealed that a small number of mothers (14 of 246) reported that they never gave their infant a bottle (ie, percentage of daily feedings that came from a bottle was 0 at birth, 3 months, and 6 months); therefore, sensitivity analyses were conducted by rerunning all models excluding these mothers to examine whether they had undue influence on findings. Statistical significance was defined as $P < .05$; statistical trends were noted when $P < .10$.

RESULTS

Sample Characteristics

Table 1 presents baseline characteristics for the total sample, as well as by PSE vs control clinics. Mean \pm standard deviation (SD) infant age at newborn enrollment into the WIC program was 11.4 ± 8.9 days (range, 0 to 52 days) and mean \pm SD mother age was 28.7 ± 6.2 years (range, 18 to 48 years). Forty percent ($n = 99$) of mothers had a high school degree or less, 27% ($n = 63$) reported their family's income was $< \$10,000$, and 38% ($n = 93$) were primiparous. The majority of mothers were Hispanic (78.6%, $n = 191$). At the time of newborn enrollment, 30% ($n = 74$) of mothers were exclusively breastfeeding their infant, 43% ($n = 106$) were feeding their infant a combination of breast milk and formula, and 27% ($n = 66$) were exclusively formula-feeding; mean \pm SD

Table 1. Demographic characteristics of 124 mother–infant dyads from 3 WIC^a clinics wherein PSE^b strategies for promoting responsive bottle-feeding were implemented and 122 mother–infant dyads from 3 control clinics

Characteristics	Total sample (n = 246)	PSE clinics (n = 124)	Control clinics (n = 122)	F value ^c	P value ^c
	←-----n (%)-----→				
Infant sex, female	113 (45.9)	61 (49.2)	52 (42.6)	1.07	.301
	←-----mean ± SD ^d -----→				
Weight-for-age z score at birth ^e	-0.13 ± 0.97	-0.20 ± 0.98	-0.07 ± 0.97	.75	.386
Infant age at newborn enrollment, d ^f	11.4 ± 8.9	10.9 ± 8.4	11.8 ± 9.3	.41	.522
Mother age at newborn enrollment, y ^g	28.7 ± 6.2	28.5 ± 6.1	29.0 ± 6.4	.46	.499
	←-----n (%)-----→				
Mother education level ^h				.68	.409
Less than high school diploma	36 (14.7)	21 (17.1)	15 (12.3)		
High school diploma	63 (25.7)	34 (27.6)	29 (23.8)		
Some college or associates	115 (46.9)	58 (47.2)	57 (46.7)		
College degree	31 (12.7)	10 (8.1)	21 (17.2)		
Parity, primiparous ⁱ	93 (38.3)	45 (36.3)	48 (40.3)	.42	.517
Annual family income ^j				.59	.444
<\$10,000/y	63 (27.0)	33 (28.5)	30 (25.6)		
\$10,000 to <\$25,000/y	85 (36.5)	39 (33.6)	46 (39.3)		
≥\$25,000/y	85 (36.5)	44 (37.9)	41 (35.0)		
Ethnicity, Hispanic ⁱ	191 (78.6)	105 (84.7)	86 (72.3)	4.49	.035
Preferred language				.93	.335
English	211 (85.8)	109 (87.9)	102 (83.6)		
Spanish	35 (14.2)	15 (12.1)	20 (16.3)		
Feeding type at birth ^k				3.53	.062
Exclusive breastfeeding	122 (50.0)	53 (42.7)	69 (57.5)		
Any breastfeeding	84 (34.4)	52 (41.9)	32 (26.7)		
Exclusive formula-feeding	38 (15.6)	19 (15.3)	19 (15.8)		
Feeding type at newborn assessment				.21	.644
Exclusive breastfeeding	74 (30.0)	33 (26.6)	41 (33.6)		
Any breastfeeding	106 (43.1)	54 (43.6)	52 (42.6)		
Exclusive formula-feeding	66 (26.8)	37 (29.8)	29 (23.8)		
	←-----mean ± SD-----→				
Daily feedings from bottles at newborn assessment, % ^f	52.2 ± 40.5	56.8 ± 39.4	47.5 ± 41.2	1.84	.176

^aWIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

^bPSE = policy, systems, and environmental.

^cFor comparison between PSE and control clinics.

^dSD = standard deviation.

^en = 220; data missing for 26 infants.

^fn = 241; data missing for 5 infants.

^gn = 240; data missing for 6 mothers.

^hn = 245; data missing for 1 mother.

ⁱn = 243; data missing for 3 mothers.

^jn = 233; data missing for 13 mothers.

^kn = 244; data missing for 2 mothers.

percentage of daily feedings that came from a bottle was $52.2\% \pm 40.5\%$ (range, 0% to 100%). There were no significant differences between the PSE and control clinics with the exception of maternal ethnicity ($P = .035$).

Effects of PSE Strategies on Risk for RWG

Twenty percent ($n = 19$) of infants in the PSE clinics exhibited RWG compared with 33% ($n = 33$) of infants in the control clinics. As illustrated in Table 2, there was a significant effect of the PSE strategies on risk for RWG ($P = .014$). Infants in the PSE clinics had 64% lower likelihood of exhibiting RWG compared with infants in the control clinics. Sensitivity analysis revealed the effect of PSE strategies on risk for RWG

remained significant ($P = .016$) when mothers who never gave their infant a bottle were excluded.

Responsive and Pressuring Feeding Styles and Practices

There were no effects of the PSE strategies or time \times PSE strategies interactions for mothers' self-reported level of responsive feeding style, pressuring feeding style, or encouragement of bottle-emptying (Table 3; available at www.jandonline.org). Mothers' level of responsive feeding style was stable over time ($P = .304$), whereas decreases between birth and 6 months were seen for pressuring feeding style ($P < .0001$) and encouragement of bottle-emptying ($P = .0008$). Sensitivity analysis revealed these findings were unchanged when mothers who never gave their infant a bottle were excluded.

Breast- and Bottle-Feeding Patterns

As illustrated in the Figure, prevalence of exclusive breastfeeding and any breastfeeding decreased over time, whereas prevalence of exclusive formula-feeding increased over time ($P = .006$). In PSE clinics, prevalence of exclusive breastfeeding decreased from 27% ($n = 33$) to 19% ($n = 21$) between the newborn and 6-month assessments, respectively. Similar decreases were seen for infants in control clinics (newborn: 34%, $n = 41$; 6 months: 22%, $n = 25$). In addition, prevalence of any breastfeeding in PSE clinics decreased from 44% ($n = 54$) to 16% ($n = 18$) between the newborn and 6-month assessments, respectively. Similar decreases were seen for infants in control clinics (newborn: 43%, $n = 52$; 6 months: 13%, $n = 15$). Prevalence of exclusive and any breastfeeding was similar for mothers in the PSE and control clinics ($P = .813$), suggesting the PSE strategies did not negatively affect breastfeeding rates.

There was a significant effect of time on the percentage of daily feedings that came from a bottle ($P < .001$; Table 3; available at www.jandonline.org), indicating that the amount of bottle-feeding that occurred increased across the first 6 months postpartum for mothers in both the PSE and control clinics. There was no effect of the PSE strategies ($P = .470$) or interaction between the PSE strategies and time ($P = .327$) on percent bottle-feeding. Thus, the PSE strategies did not have an unintended effect of promoting greater levels of bottle-feeding. Sensitivity analysis revealed these findings were unchanged when mothers who never gave their infant a bottle were excluded.

Mothers' Perceptions of and Experiences with WIC

Overall, mothers in both the PSE and control clinics agreed that WIC supports their decision to breastfeed ($P = .454$); this perception remained high and stable between 3 and 6 months ($P = .564$; Table 4; available at www.jandonline.org). However, mothers in PSE clinics trended toward feeling more supported with respect to their decision to bottle-feed at both the 3- and 6-month assessments compared with mothers in control clinics ($P = .098$).

Mothers in the PSE and control clinics were equally satisfied with their experience with WIC ($P = .800$) and indicated that their experiences at WIC made them want to continue ($P = .814$). They also reported that they were equally likely to keep coming to WIC after formula benefits end ($P = .599$). However, when asked—"How long do you think you will keep

Table 2. Risk for RWG^a for infants from 3 WIC^b clinics wherein PSE^c strategies for promoting responsive bottle-feeding were implemented compared with infants from 3 control clinics

Variable	OR ^d estimate	95% CI
Clinic		
PSE	0.36	0.16 to 0.81
Control	Reference	—
Covariates		
Age at last WAZ ^e measure	1.01	0.99 to 1.02
Birth WAZ	0.27	0.16 to 0.47
Mother education level		
Less than high school diploma	2.43	0.53 to 11.16
High school diploma	1.62	0.43 to 6.16
Some college or associates	1.17	0.33 to 4.20
College degree	Reference	—
Parity		
Multiparous	1.23	0.55 to 2.77
Primiparous	Reference	—
Annual family income		
<\$10,000/y	1.25	0.42 to 3.74
\$10,000 to <\$25,000/y	1.61	0.65 to 4.03
≥\$25,000/ys	Reference	—
Age at introduction of CFBs ^f	0.89	0.58 to 1.37
Cereal added to bottles^g		
Yes	1.45	0.50 to 4.24
No	Reference	—
Percent bottle-feeding	1.00	0.99 to 1.01

^aRWG = rapid weight gain, defined as WAZ change >0.67 .

^bWIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

^cPSE = policies, systems, and environmental.

^dOR = odds ratio; from logistic regression with estimation via generalized estimating equation.

^eWAZ = weight-for-age z score.

^fCFBs = complementary foods and beverages.

^gBased on mothers' reports of whether they regularly added cereal to some or all of their infants' bottles.

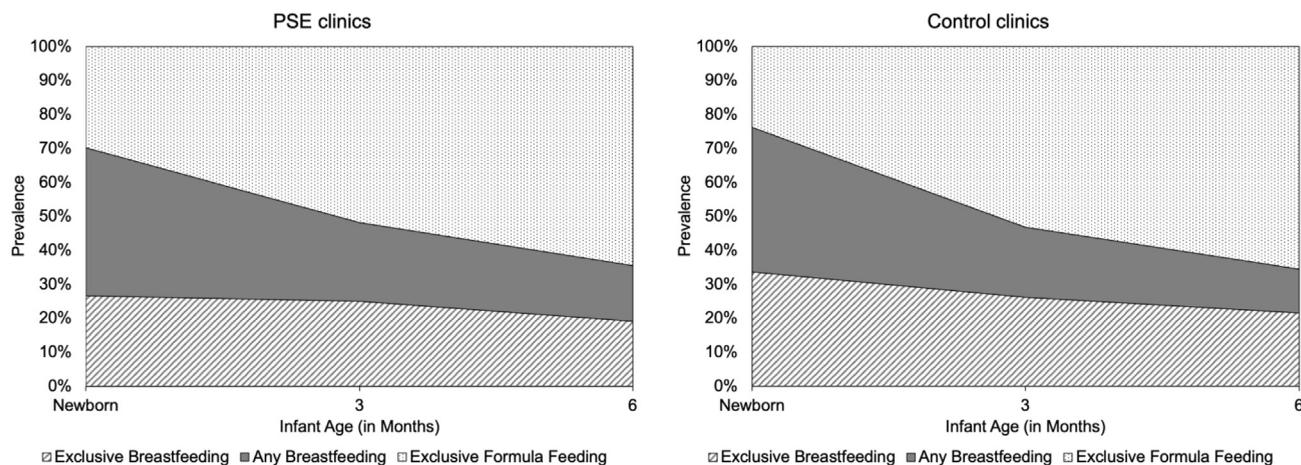


Figure. Prevalence of exclusive breastfeeding, any breastfeeding, and exclusive formula feeding over time for mother–infant dyads ($n = 124$) from 3 Special Supplemental Nutrition Program for Women, Infants, and Children clinics wherein policy, systems, and environmental strategies for promoting responsive bottle-feeding were implemented (policy, systems, and environmental strategies [PSE] clinics; $n = 124$) vs for mother–infant dyads from 3 control clinics ($n = 122$).

coming to WIC?”—there was a time \times PSE strategies interaction ($P = .002$). Mothers in PSE clinics exhibited a marginal increase in their predicted duration between 3 and 6 months ($P = .080$), whereas mothers in control clinics exhibited a significant decrease in their predicted duration between 3 and 6 months ($P = .009$). Sensitivity analysis revealed these findings were unchanged when mothers who never gave their infant a bottle were excluded.

DISCUSSION

Within the present study, the effectiveness of PSE strategies for promoting responsive bottle-feeding practices among WIC mothers with young infants was evaluated. PSE strategies included more inclusive assessment of infant feeding during early infancy, which allowed for more tailored counseling and formula issuance, and increased education and support for responsive bottle-feeding. Implementation of these PSE strategies was associated with reduced risk for RWG among infants in PSE clinics; infants in PSE clinics had a significantly lower likelihood of exhibiting RWG compared to infants in control clinics.

Given bottle-feeding is one of the earliest postnatal risk factors for RWG during infancy,^{20–22,47} the ideal form of primary prevention would be robust breastfeeding-promotion efforts that successfully increase breastfeeding initiation and duration. If successful, these efforts would ensure that all infants are exclusively fed breast milk directly from the breast for the first 6 months postpartum, with continued breastfeeding through the first year and beyond. Indeed, WIC has made a significant investment in breastfeeding-promotion efforts, implementing evidence-based breastfeeding-promotion practices, such as access to lactation consultants and peer counselors.^{30,48,49} These efforts have led to significant increases in breastfeeding initiation and duration rates among WIC mothers, which is commendable.^{28–30}

However, it is important to note that most recent data illustrate that breastfeeding rates among WIC mothers are still below national health goals, with approximately 70% of WIC infants ever breastfed and only 34% still breastfed at 6

months of age.^{50–52} Similar trends were seen within the present study and significant increases in the percentage of daily feedings from a bottle between birth and 6 months were noted. Implications of these findings are 2-fold. On the one hand, it is notable that PSE strategies to promote responsive bottle-feeding were not associated with increased bottle-feeding rates among WIC mothers; rather, breastfeeding rates were similar to what is typically seen within WIC samples. On the other hand, these findings suggest that despite robust breastfeeding support, many WIC mothers are still bottle-feeding and are increasing the extent to which they are bottle-feeding over time. These trends support the notion that secondary prevention strategies are needed to complement primary prevention efforts that promote breastfeeding. In addition, the present study suggests that these secondary prevention strategies—such as the PSE strategies tested in the present study—may help mitigate risk for RWG among bottle-feeding infants.

Focusing secondary prevention efforts on bottle-feeding dyads is also important in light of a growing body of literature illustrating that bottle-feeding mothers report receiving inadequate support for learning healthy bottle-feeding practices from health care providers, partially because greater emphasis is placed on breastfeeding.^{34,53} This problem is accentuated in low-income, minority populations who have greater risk of using unhealthy bottle-feeding practices and are more likely to seek out friends and family, instead of professionals, for infant-feeding advice.^{54,55} A paucity of studies has focused on improving the feeding practices of bottle-feeding mothers during early infancy and one of the only randomized interventions focused on improving bottle-feeding practices of WIC mothers illustrated that low-intensity educational intervention alone was insufficient to improve feeding practices in mothers,⁵⁶ suggesting that more robust strategies are needed to improve WIC mothers' bottle-feeding practices.

The focus of the PSE strategies was to expand early feeding assessments and responsive-feeding education to meet the needs of WIC mothers; the aim of these changes was to better tailor WIC practice to “meet mothers where they are” and

provide the support they need to feed their infants well, regardless of whether they are breast- or bottle-feeding. Responsive feeding has been a primary focus of recent obesity-prevention efforts, and interventions to promote responsive feeding and parenting have shown some success in improving parent feeding practices and reducing infants' risk for later obesity.^{15,57-59} This study was among the first to specifically focus on development and evaluation of PSE strategies to promote responsive bottle-feeding; a strength of a PSE approach is its potential for a broader reach and greater sustainability compared with individual-level behavior change strategies.³⁵⁻³⁷ It was hypothesized that these strategies would yield individual-level changes in the form of increases in mothers' reports of responsive feeding and decreases in reports of pressuring feeding. But, despite positive effects on infant weight gain, effects of the intervention on responsive or pressuring feeding practices and styles were not seen. Two possible explanations, not mutually exclusive, for these seemingly discrepant findings are offered.

First, measures of feeding practices and styles were self-report, whereas measures of infant weight gain were objective and conducted by trained WIC staff. Although some studies of parents of older children suggest self-report measures of feeding practices correlate with observational measures, other studies suggest social desirability may bias these measures.⁶⁰⁻⁶² Second, it is important to note that existing WIC education and counseling already follow a well-developed curriculum focused on promoting mothers' responsiveness to infant cues and understanding of infant behavior and developmental stages.³¹ It is possible that this education and counseling led to the relatively higher levels of responsive feeding and lower levels of pressuring feeding seen for mothers in both PSE and control clinics, thus creating either socially desirable responding or tangible impacts on maternal feeding styles that led to scale attenuation effects. Future research that includes objective measures of feeding practices and styles, assessment of other domains of feeding (eg, use of food to soothe), and a non-WIC comparison group may provide further insights.

Implications of PSE strategies to promote healthy bottle-feeding may extend beyond positive effects on maternal feeding practices and infant weight outcomes. Previous work with WIC participants illustrates that fully formula-fed infants are less likely to continue participating in WIC after the first year and this timing aligns with the discontinuation of the WIC formula benefit.^{32,33} In addition, although many mothers report positive experiences with and perceptions of the WIC program, formula-feeding mothers report feeling judged by WIC staff for not breastfeeding and feel these negative experiences decrease their motivation to recertify their infant after formula benefits end.³⁴ Findings from the present study suggest the beginning of this disengagement from the WIC program may start as early as 6 months of age, with mothers in the control group exhibiting a significant decrease in their predicted duration of participation between 3 and 6 months of age. Thus, efforts to keep formula-feeding families engaged in the WIC program beyond age 1 year need to start early. There is ample evidence that longer duration of WIC participation is associated with healthier growth patterns and better diet quality for children⁶³; thus, strategies that engage participants early are likely to have long-term benefits. This study suggests that the combination of

breastfeeding support and responsive bottle-feeding support may contribute to intentions for longer WIC participation; further research with longer-term follow-up is warranted.

Limitations of this study include reliance on self-report for all measures of infant feeding. Although all measures used in the study were validated measures, the possibility that social desirability might have influenced responses cannot be ruled out. Inherent to research taking place in an applied setting, participants within a WIC clinic could not be randomly assigned to be exposed to the PSE strategies while others within the same WIC clinic were not exposed to the strategies. Although PSE and control clinics were matched on characteristics likely to impact study outcomes, there were still significant differences between PSE and control clinics for the proportion of mothers who identified as Hispanic. In addition, it is possible that unmeasured differences between the PSE and control clinics, such as maternal employment, maternity leave, and the extent to which the mother vs other caregivers were responsible for infant feeding, contributed to outcomes. In addition, the high prevalence of Hispanic mothers in this sample was a strength, given Hispanic families are at greater risk for overfeeding, obesity, and related comorbidities than other racial and ethnic groups^{54,64}; however, mothers who identified as Black or other races and ethnicities were under-represented, limiting abilities to generalize these findings to more racially and ethnically diverse populations. Finally, although all data collection through age 6 months was completed before onset of the COVID-19 pandemic, a limitation of this study is that potential effects of the PSE strategies on behavior change or infant growth after 6 months of age could not be assessed.

CONCLUSIONS

This study was among the first to specifically evaluate PSE approaches to promote healthy bottle-feeding within a WIC setting. Promising effects of these PSE strategies on reducing infants' risk for RWG were seen, as well as on mothers' perceptions of support and intentions to remain in the WIC program. These findings, paired with the broad reach of the WIC program to nearly half of all infants born in the United States,²⁷ support the importance of embedding PSE strategies to prevent RWG. Of note, PSE strategies to promote healthy bottle-feeding did not undermine WIC efforts to support breastfeeding, suggesting these PSE strategies may be an effective complement to existing breastfeeding support measures within WIC. Taken together, these findings suggest additional research is warranted to further refine and disseminate these PSE strategies and explore additional ways in which risk for RWG can be mitigated through the integration of primary prevention through breastfeeding promotion and secondary prevention through promotion of responsive bottle-feeding.

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STATEMENT OF POTENTIAL CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

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AUTHOR CONTRIBUTIONS

A. K. Ventura and S. E. Whaley designed the study, oversaw all aspects of data collection, management, and analysis, and reviewed, revised, and finalized the manuscript. K. Silva Garcia assisted with data analysis and interpretation and reviewed the final manuscript. M. Meza, E. Rodriguez, and C. E. Martinez assisted with study design and execution, data collection and data management and reviewed the final manuscript.

Table 3. Change in feeding styles and practices between birth and 6 months for mothers from 3 WIC^a clinics wherein PSE^b strategies for promoting responsive bottle-feeding were implemented compared with mothers from 3 control clinics

Variable	Responsive feeding style	Pressuring feeding style	Encouragement of bottle emptying	Percent bottle-feeding ^d
	← estimate (standard error) →			
Intercept	4.75 (0.11) ^{***}	2.50 (0.14) ^{***}	2.46 (0.27) ^{**}	47.18 (7.90) ^{**}
Month				
Birth	Reference	Reference	Reference	Reference
3	−0.11 (0.07)	−0.27 (0.07) ^{**}	−0.33 (0.18)	23.76 (3.53) ^{***}
6	−0.12 (0.06)	−0.28 (0.08) ^{**}	−0.40 (0.17) [*]	28.68 (3.76) ^{***}
Clinic				
PSE	−0.12 (0.1)	0.04 (0.11)	0.05 (0.25)	10.45 (7.32)
Control	Reference	Reference	Reference	Reference
Month × clinic interaction				
Birth × PSE	Reference	Reference	Reference	Reference
3 × PSE	0.16 (0.09)	−0.11 (0.1)	0.07 (0.24)	−7.35 (4.97)
6 × PSE	0.09 (0.09)	−0.09 (0.11)	−0.15 (0.23)	−6.14 (5.35)
Covariates				
Mother education level				
Less than high school diploma	−0.15 (0.11)	−0.05 (0.16)	−0.01 (0.27)	0.42 (7.46)
High school diploma	−0.07 (0.10)	−0.09 (0.14)	−0.17 (0.23)	−4.85 (8.52)
Some college or associates	−0.01 (0.09)	−0.18 (0.13)	0.02 (0.21)	1.33 (6.84)
College degree	Reference	Reference	Reference	Reference
Parity				
Multiparous	−0.03 (0.06)	−0.12 (0.08)	0.01 (0.14)	−4.23 (4.52)
Primiparous	Reference	Reference	Reference	Reference
Annual family income				
<\$10,000/y	−0.12 (0.06)	0.22 (0.08) ^{**}	0.29 (0.16)	2.84 (3.56)
\$10,000 to <\$25,000/y	−0.03 (0.05)	0.1 (0.07)	0.18 (0.14)	2.28 (2.58)
≥\$25,000/y	Reference	Reference	Reference	Reference
Percent bottle-feeding ^c	0.01 (0.01) [*]	0.00 (0.00)	0.00 (0.00)	—

^aWIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

^bPSE = policies, systems, and environmental.

^cEach column represents a separate linear mixed model testing the significance of differences between PSE and control clinics for level of (main effect of clinic) and change over time for (month × clinic interaction) in responsive feeding style, pressuring feeding style, encouragement of bottle emptying, and percent bottle-feeding, respectively.

^dPercentage of daily breast milk or formula feedings that came from a bottle.

^{*}*p* < .05.

^{**}*p* < .01.

^{***}*p* < .001.

Table 4. Change in perceptions of WIC^a experiences between birth and 6 months for mothers from 3 WIC clinics wherein PSE^b strategies for promoting responsive bottle-feeding were implemented compared with mothers from 3 control clinics^c

Variable	Support for breastfeeding	Support for bottle-feeding	Satisfaction with WIC	Desire to continue in WIC	Continuation after formula benefits end	Predicted duration of participation
	← ----- estimate (standard error) ----- →					
Intercept	5.04 (0.07) ^{***}	3.58 (0.25) ^{***}	4.79 (0.10) ^{***}	4.74 (0.10) ^{***}	4.68 (0.28) ^{***}	4.29 (0.28) ^{***}
Month						
3	Reference	Reference	Reference	Reference	Reference	Reference
6	0.03 (0.07)	0.23 (0.13)	0.05 (0.05)	0.00 (0.06)	−0.23 (0.15)	−0.25 (0.1) ^{**}
Clinic						
PSE	0.01 (0.05)	0.34 (0.17) [*]	0.09 (0.06)	0.03 (0.06)	−0.24 (0.15)	−0.16 (0.22)
Control	Reference	Reference	Reference	Reference	Reference	Reference
Month × clinic interaction						
3 × PSE	Reference	Reference	Reference	Reference	Reference	Reference
6 × PSE	−0.12 (0.09)	−0.22 (0.18)	−0.16 (0.07)	−0.03 (0.08)	0.35 (0.2)	0.41 (0.13) ^{**}
Covariates						
Mother education level						
Less than high school diploma	0.05 (0.08)	0.25 (0.26)	0.19 (0.10)	0.21 (0.10)	0.30 (0.23)	0.21 (0.28)
High school diploma	−0.04 (0.07)	0.27 (0.23)	0.13 (0.09)	0.14 (0.09)	0.04 (0.19)	0.41 (0.24)
Some college or associates	−0.05 (0.07)	0.13 (0.21)	0.01 (0.08)	0.05 (0.08)	0.04 (0.17)	0.11 (0.22)
College degree	Reference	Reference	Reference	Reference	Reference	Reference
Parity						
Multiparous	−0.04 (0.04)	−0.16 (0.14)	0.00 (0.05)	0.04 (0.05)	0.15 (0.11)	0.54 (0.15) ^{**}
Primiparous	Reference	Reference	Reference	Reference	Reference	Reference
Annual family income						
<\$10,000 per year	−0.09 (0.06)	−0.19 (0.17)	−0.13 (0.07)	−0.1 (0.07)	−0.02 (0.15)	−0.16 (0.16)
\$10,000 to <\$25,000 per year	−0.09 (0.05) [*]	−0.17 (0.14)	−0.05 (0.06)	−0.01 (0.06)	0.01 (0.13)	−0.1 (0.12)
≥ \$25,000 per year	Reference	Reference	Reference	Reference	Reference	Reference
Percent bottle-feeding^d	0.00 (0.00)	0.01 (0.00) ^{***}	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)

^aWIC = Special Supplemental Nutrition Program for Women, Infants, and Children.^bPSE = policies, systems, and environmental.^cEach column represents a separate linear mixed model testing the significance of differences between PSE and control clinics for level of (main effect of clinic) and change over time for (month × clinic interaction) perceptions of WIC experiences.^dPercentage of daily breast milk or formula feedings that came from a bottle.**p* < .05.***p* < .01.****p* < .001.