

Maternal Prepregnancy Body Mass Index and Initiation and Duration of Breastfeeding: A Review of the Literature

Janet M. Wojcicki, Ph.D., M.P.H.

Abstract

Background: Previous studies have found an association between maternal obesity and overweight and breastfeeding (BF) difficulties, including delayed lactogenesis and shorter duration of BF. Biological, psychological, and mechanical causes have been linked with poor BF outcomes. Other review articles on this topic have included studies that measured maternal body mass index (BMI) in the postpartum period instead of prenatally, presenting difficulties in teasing out the role of gestational weight gain and prepregnancy BMI on BF success. My objective was to evaluate the relationship between maternal prepregnancy BMI, including comorbidities associated with overweight and obesity such as diabetes mellitus, and BF initiation and duration.

Methods: Four PubMed searches were conducted, retrieving 13 articles.

Results: Of the 12 studies reviewed that assessed the association between prepregnancy maternal BMI category and BF initiation, 9 found an association between maternal overweight or obesity and delayed lactogenesis or failure to initiate BF. One study found increased risk for not initiating BF only in Hispanic women, and 1 found the association only among women with medical comorbidities in addition to obesity. Of the 13 studies retrieved that assessed the association between BMI category and BF duration, 10 found an association between higher BMI categories and shorter duration of BF. Ten of the 13 studies reviewed adjusted for multiple confounders, including maternal smoking status, parity, type of delivery, and infant birthweight. The studies that found an association between BMI category and reduced duration did so in some cases only for certain ethnic/racial groups or BMI categories or if other comorbidities were present in addition to overweight/obesity.

Conclusions: Higher BMI levels can adversely impact BF initiation and duration. Further studies need to be conducted to better understand the role of race/ethnicity, gestational weight gain, and such comorbidities as diabetes in increasing risk for reduced BF initiation and duration in overweight and obese women.

Introduction

THE SURGEON GENERAL'S HEALTH GOALS for 2010 include a goal to have 75% of women initiate breastfeeding (BF) and 50% to continue BF through 6 months of age.¹ The American Academy of Pediatrics (AAP) recommends exclusive BF until 6 months of age and BF until 12 months of age.² Unfortunately, American women are not meeting these goals, with specific population groups being at increased risk, including lower-income and African American women.³ Recent data also suggest that women who are overweight (defined as having a body mass index [BMI] ≥ 25 kg/m²) or obese (BMI ≥ 30 kg/m²), using National Institutes of Health [NIH] classifications,⁴ may be at particular risk for failure to initiate BF as well as early cessation. Possible biological/hormonal reasons for this include delayed

lactogenesis related to a delayed prolactin response,⁵ and reasons related to body shape include issues with positioning the infant.⁶

Other psychological issues, including embarrassment related to body size/shape while nursing in public, have been suggested as being associated with reduced initiation and duration, as have mechanical issues, such as larger breasts or nipples that may create additional latching challenges.⁷ A systematic review by Amir and Donath⁸ found that obese women have different intentions, and plan to breastfeed for a shorter duration than normal weight woman. In the United States, the prevalence of overweight and obesity among women of childbearing ages is greater than one third in this population group (28.9% overweight and 8.0% obese), suggesting the importance of addressing overweight and obese women as a high-risk group in any public health intervention

to increase rates of BF initiation and duration.⁹ Furthermore, U.S. women are not unique, as obesity is a global epidemic impacting adults. Mexico and China have prevalences comparable to that of the United States, particularly in urban areas.¹⁰

Although studies suggest that overweight and obese women struggle more to follow the AAP recommendations for BF initiation and duration, it is not clear which factors are most significant in terms of increasing risk or if racial/ethnic factors interact with maternal BMI in impacting BF patterns. Additionally, it is not clear if obese vs. overweight mothers are at greater risk and, within the obese category, if the severely obese (BMI ≥ 35 kg/m² or BMI ≥ 40 kg/m²) are at higher risk for reduced BF initiation or duration; only a few studies have stratified obese women into multiple categories.¹¹ Because maternal overweight and obesity in pregnancy are associated with a number of comorbidities (e.g., preexisting diabetes mellitus and gestational diabetes mellitus) and specific labor and delivery complications (e.g., increased risk for cesarean delivery and macrosomic infant birth), additional disease processes and increases in adipose tissue in overweight/obese women might be associated with these increased risks for BF issues.¹²

Previous reviews on this topic⁸ have included studies that use a prenatal or postpartum definition of obesity (measuring BMI in the early postpartum period or while pregnant) and studies that use a prepregnancy BMI, which likely conflates issues of prepregnancy BMI with gestational weight gain. As both of these factors could potentially impact BF initiation and duration, this review evaluated only those studies that use a prepregnancy BMI, many of which also evaluated gestational weight gain. This review, in contrast to previous reviews,^{8,13} also took into consideration specifically the role of preexisting and gestational diabetes mellitus, labor and delivery complications, and the role of racial/ethnic factors (specifically African American, Latino, and white race/ethnicity in the United States, African origin and European in Europe, and European origin and Aboriginal in Australia) in mediating the relationship between overweight/obesity and risk for failure to initiate BF or BF duration.

Materials and Methods

Inclusion criteria for the review included prospective or retrospective longitudinal or cross-sectional studies that included a measure of maternal prepregnancy BMI and BF initiation or duration. Studies in all languages and from all countries were included. A PubMed search was conducted using the entire database in October 2010, with the following search terms: maternal obesity and breastfeeding problems, maternal obesity and breastfeeding cessation, maternal obesity and delayed lactogenesis, and maternal obesity and breastfeeding initiation. The first search netted 17 articles, but a high number were reviews (9) or the study did not address the question of the relationship between maternal obesity and BF initiation or duration ($n=7$), resulting in only 1 article from the first search. The second search resulted in 11 articles, with 3 not addressing the relationship between maternal obesity and BF outcomes, 5 excluded as they were reviews, 1 excluded as there was no measure of prepregnancy BMI, and 2 meeting the study criteria. The third search resulted in 5 articles, of which 4 were reviews and 1 did not have a measure

of prepregnancy BMI. The last search resulted in 25 studies, of which 6 met the inclusion criteria and the rest included reviews ($n=5$), commentaries/position papers ($n=3$), studies that did not meet the study criteria including those studies that did not have a measure of prepregnancy BMI ($n=7$), and 4 studies that had been retrieved from previous searches. The four searches on PubMed resulted in 9 studies that met the inclusion criteria. An additional 4 studies were retrieved in the references from the review by Amir and Donath,⁸ resulting in 13 studies that met the inclusion criteria for this review.

Studies were evaluated based on the following criteria: (1) the time period evaluated (BF initiation, including definition of initiation or duration and length of duration), (2) ethnic/racial background (for the U.S. studies this included African American and Latino populations; for the European studies African origin, and for the Australian studies Asian origin populations and Aboriginal), (3) what additional variables were evaluated in addition to evaluating the primary relationship between overweight/obesity and BF duration and initiation, with particular attention to medical comorbidities, parity, gestational weight gain, and other possible confounders, and (4) study design and sample size.

Results

Of the 13 studies that met the inclusion criteria for the review, 12 evaluated initiation and duration of BF,^{11,14–24} and 1 evaluated BF duration only²⁵ (Table 1). All studies (except the study by Grijbovski et al.,¹⁴) that found an association between the outcome of interest (BF initiation or duration) and maternal obesity or overweight did so in the same direction: women who were overweight or obese had increased risk for failure to initiate BF or had decreased duration. The studies were conducted in United States ($n=8$), Australia ($n=2$), Russia ($n=1$), Greece ($n=1$), Denmark ($n=1$), France ($n=1$), and Canada ($n=1$).

Of the 12 studies that evaluated initiation, 9 found an association between higher BMI categories and failure to initiate BF (defined either by no BF at all or no BF on discharge from hospital).^{11,15,16,18–23} Of the 13 studies that evaluated BF duration, 10 found an association between maternal obesity or overweight and reduced duration of BF^{17–21,23–25} (Table 1). For some of the studies, the results were heterogeneous (present for BF initiation but not duration, or *vice versa*), or the association was present only for specific population groups and not others.

Ethnic and racial factors

Two of the 9 studies finding an association between higher BMI and failure to initiate BF found these associations only in certain ethnic groups (only Hispanic but not African American¹⁹ and only white but not African American.²¹ Similarly, 2 of the 10 studies that found an association between overweight/obesity and BF duration found these relationships significant only for Hispanics but not African Americans¹⁹ and only white Americans but not African Americans.²¹ Most of the studies in the review were conducted exclusively with white, European-origin women in spite of the diverse international locations (e.g., Canada, France, Russia), with the exception of the studies by Li et al.²⁰ and by Kitsantas and Pawloski,¹⁸ which had sizable Hispanic and African American

groups. The Australian study by Oddy et al.²⁴ had a small Asian and Aboriginal minority group. However, these three studies did not conduct a stratified analysis to assess the interaction between obesity and race/ethnicity, as did Kugyelka et al.¹⁹ and Liu et al.²¹ but rather adjusted for race/ethnicity in the analysis. After adjustments, Li et al.,²⁰ Kitsantas and Pawloski,¹⁸ and Oddy et al.²⁴ continued to find an association between maternal overweight/obesity and reduced BF duration and increased risk for failure to initiate BF.

A few studies did not provide any data on race/ethnicity, including the large study by Donath and Amir¹¹ of Australian children ($n = 3075$) and the study by Kehler et al.¹⁷ in Alberta, Canada ($n = 780$).

Medical complications, including gestational and preexisting diabetes

Two studies excluded women who had preexisting or gestational diabetes,^{19,25} and 2 adjusted for medical complications, including preexisting or gestational diabetes in multivariate analyses.^{21,24} These 4 studies continued to find an association between maternal overweight/obesity status and failure to initiate BF or early cessation after these adjustments. Only 1 study review stratified by medical and labor/delivery complications¹⁸ and evaluated the interaction between overweight and obesity and women with medical and labor/delivery complications. This study found that only the overweight and obese women who had medical or labor/delivery complications were less likely to initiate exclusive BF. The types of medical or delivery complications included hypertension, fetal distress, gestational diabetes, and meconium, among others. In this same study, overweight and obese women with medical or delivery complications were also at a greater risk for stopping BF.

Possible confounders, including gestational weight gain, parity, infant birthweight, delivery type, and maternal smoking status

Because of possible confounding effects, several studies controlled for delayed lactogenesis and parity, infant birthweight, type of delivery (vaginal vs. cesarean section), and maternal smoking. Primiparity, higher birthweight, cesarean section delivery, and smoking have all been shown to be associated with reduced risk for BF initiation and duration. The studies that did not control for all these variables included the smaller studies, such as the one by Hilson et al.,¹⁶ which controlled only for parity ($n = 151$) the study by Mok et al.²³ ($n = 222$), which matched on maternal parity, and the larger Russian study by Grijboski et al.¹⁴ ($n = 1399$), which controlled for all except for maternal smoking. Some studies did not adjust for delivery type (cesarean section vs. vaginal), including the study by Li et al.²⁰ and that by Kehler et al.¹⁷ (Table 1).

A few studies analyzed the possible interaction between gestational weight gain and maternal prepregnancy BMI. Manios et al.²² evaluated gestational weight gain separately from prepregnancy BMI, finding that the two variables were highly correlated in regression analyses. The study by Baker et al.²⁵ found that gestational weight gain did not interact with or confound the relationship between prepregnancy BMI and terminating BF, although gestational weight gain increased the odds of termination of BF inconsistently when prepregnancy BMI was not in the model. Lastly, Li et al.²⁰ found a

significant interactive effect between prepregnancy BMI gestational weight gain and failure to initiate BF but not for BF duration.

Only 1 study adjusted for maternal knowledge of BF and behavior.¹⁶ This study did not find any association between BMI category and exclusive BF and any BF duration after controlling for BF behavior.¹⁶

Maternal BMI category and definition

Some of the studies reviewed found an association between maternal obesity and failure to initiate BF or increased risk for early cessation but did not find the same relationships in overweight women.^{19,20,22,23} One study found increased risk only in very obese women ($\text{BMI} \geq 35$).²¹ Baker et al.²⁵ found progressively higher relative risks of termination of any BF and exclusive BF based on obesity class (Table 1). Studies also used different definitions of obesity, with 5 studies using the NIH classification,⁴ with obesity $\geq 30 \text{ kg/m}^2$ ^{11,22–25} and 7 others using the Institute of Medicine's classifications,²⁷ with obesity $>29.0 \text{ kg/m}^2$.^{13,15,17–21} The study by Grijboski et al.¹⁴ did not specify how BMI category was calculated.

Study design and study sample size

All the studies reviewed used a longitudinal design, with 5 collecting data on BF retrospectively.^{11,14,15,17,22} Most of the studies reviewed had more than 1000 participants, except the studies by Hilson et al. ($n = 151$),¹⁶ Mok et al. ($n = 222$),²³ and Kehler et al. ($n = 780$)¹⁷ which were still relatively large studies.

Discussion

The results of this review indicate, as other reviews have suggested,⁸ that women who are overweight or obese have increased reduced rates of BF initiation and earlier termination. In contrast to previous reviews, however, this review suggests that these relationships need to be further clarified, particularly in relationship to race/ethnicity and medical complications, such as diabetes mellitus. As some studies found obesity differentially impacts African American women with less risk for failure to initiate and terminate BF in comparison with white and Latina women, it is important to further clarify if these differences might be attributed to sociocultural, environmental, or physiological factors.

Additionally, future studies should evaluate the role that medical complications, particularly gestational diabetes, may play in impacting BF initiation and duration patterns. The 1 study¹⁸ reviewed here that evaluated an interactive effect of medical/labor complications did not find an independent effect of maternal overweight/obesity on BF initiation or duration; only obese women with medical/labor complications had increased risk for failure to initiate BF and greater risk of stopping BF. The other studies reviewed here either excluded women with gestational diabetes mellitus or did not assess the possible role of diabetes in BF patterns.

Clinical and physiological data with women with diabetes mellitus suggest possible hormonal reasons for delayed lactogenesis, including a reduced amount of circulating human placental lactogen, which is positively correlated with breast growth in pregnancy.²⁷ A recent study found that term infants born to mothers with gestational diabetes mellitus treated

TABLE 1. STUDIES INCLUDED IN REVIEW

<i>Study</i>	<i>Study design</i>	<i>Time period (definition of initiation or duration)</i>	<i>Number of subjects (racial/ethnic identity)</i>	<i>Other variables adjusted or excluded (e.g. cesarean section and gestational and preexisting diabetes mellitus)</i>	<i>Outcome of interest: Result in comparison to maternal obesity</i>
Breastfeeding duration studies					
Baker et al., 2007 ²⁵	Prospective cohort	Until 18 months postpartum (duration only)	37,459 (Danish)	Women with gestational diabetes excluded and those who chose not to breastfeed. Adjusted for primiparity and cesarean section, smoking in pregnancy, gestational weight gain, infant sex, infant birthweight and gestational age	Risk for early termination of BF rose with increasing pre-pregnant BMI values (RR 1.12, 95% CI 1.09-1.16) for OW and (RR 1.24, 95% CI 1.18-1.31) for OB class 1, (RR 1.37, 95% CI 1.25-1.50) for OB class 2 and (RR 1.39, 95% CI 1.19-1.63) for OB class 3. Cesarean section and primiparity also associated with increased risk for termination
Breastfeeding initiation and duration studies					
Donath and Amir, 2008 ¹¹	Retrospective cohort	Initiation (ever breastfed) and duration until 6 months	3075 women (Australia)	Cesarean section, maternal smoking, child in special care nursery, maternal age and education, SES	OB and OW women less likely to initiate (OR 2.10, 95% CI 1.49-2.96 for OB and OR 1.20, 95% CI 0.09-1.84 for OW) and cease BF at 1 week, between 1 week and 6 months, and before 6 months (OR 1.68, 9% CI 1.37-2.06 for OB and OR 1.34, 95% CI 1.12-1.60 for OW)
Grijbovski et al. 2005 ¹⁴	Retrospective cohort	Initiation (ever breastfed) and duration until 12 months of age	1,399 women in northwest Russia	Maternal age, education, type of delivery, preterm, birthweight, parity, sex	No difference in initiation and duration based on pre-pregnancy weight status (underweight, normal, or overweight) (OR 1.27, 95% CI 0.93-1.73) for OB
Hilson et al., 1997 ¹⁵	Retrospective cohort	Initiation of BF (BF throughout to hospital discharge), duration of exclusive BF, and any BF until 24 months	1,109 white women in rural, New York (USA)	Maternal age, education, parity, cesarean section, gestational diabetes mellitus, smoking, and infant birthweight and gestational age.	OW and OB women were less likely to be BF at discharge and higher rates of discontinuation of EBF (RR 1.42 for OW and RR 1.43 for OB) and any BF (RR 1.68 for OW and 1.73 for OB)
Hilson et al., 2004 ¹⁶	Prospective cohort	Onset of lactogenesis and BF duration to 8-12 months postpartum	151 white, rural women (USA)	Parity, BF knowledge and BF behavior survey	Pre-pregnant BMI was significant predictor for delayed onset of lactogenesis (OR 1.08 95% CI 1.0-1.20). No association between BMI category and EBF or duration of BF after controlling for BF behavior
Kehler et al., 2009 ¹⁷	Retrospective cohort	Initiation (ever breastfed) and duration until 6 months	780 women (Canada)	Working status, education level, and anxiety in pregnancy	No differences in initiation but maternal obesity associated with increased risk of stopping BF prior to 6 months (OR 2.13, 95% CI 1.29-3.51)

(continued)

TABLE 1. (CONTINUED)

Study	Study design	Time period (definition of initiation or duration)	Number of subjects (racial/ethnic identity)	Other variables adjusted or excluded (e.g. cesarean section and gestational and preexisting diabetes mellitus)	Outcome of interest: Result in comparison to maternal obesity
Kitsantas and Pawloski, 2009 ¹⁸	Prospective cohort	Initiation (ever breastfed) and duration (until 22 months for some children) in a nationally (USA) representative sample	10,700 (59.5% white, 20.5% Hispanic, and 14.7% black mothers) (USA)	Labor/delivery complications, including diabetes, parity, cesarean section, smoking, and infant birth-weight and sex. Race/ethnicity and gestational age also adjusted	OW/OB women with medical or labor/delivery complications less likely to initiate BF (1.24, 95% CI 1.10-1.48). OW/OB women with medical conditions or labor/delivery complications also at greater risk for stopping BF (HR 1.11, 95% CI 1.10-1.21)
Kugyelka et al., 2004 ¹⁹	Prospective cohort	Initiation (BF at hospital discharge) and duration to 6 months postpartum	587 (Hispanic) and 640 (black) (USA)	Women with insulin-dependent diabetes mellitus were excluded. Adjusted for cesarean section, parity, birthweight and smoking	OB Hispanic women (but not OW) more likely than normal weight women to not initiate EBF (OR 1.92, 95% CI 1.20-3.10). OB Hispanic also had a higher rate of discontinuation of EBF (RR 1.46, 1.06-1.99) and any BF (RR 1.55, 1.13-2.13). No differences based on BMI for blacks for initiation or duration
Li et al., 2003 ²⁰	Prospective cohort	Initiation (ever breastfed) and duration of BF until 10 months	51,329 mother-child pairs (69.2% white, 14.5% black, 14.0% Hispanic) (USA)	Birthweight, parity, smoking, gestational weight gain, race/ethnicity, poverty level. Stratified analysis was conducted for gestational weight gain	OB women less likely to initiate BF; women who were obese before pregnancy BF for 2 weeks less than normal weight women (Coeff = -1.73, $p < 0.01$)
Liu et al., 2010 ²¹	Prospective cohort	Initiation (ever breastfed) and duration until 6 months	3,517 (white) and 2,846 (black) women in South Carolina (USA)	Medical complications (including gestational diabetes), smoking, parity, GA, cesarean section, birthweight, maternal age and education	Very OB white women (BMI \geq 35) less likely to initiate BF (OR 0.63, 95% CI 0.42-0.94) and OW and very OB discontinue in first 6 months (HR 1.22, 95% CI 1.01-1.48 for OW and HR 1.89, 95% CI 1.39-2.58 for very OB). No differences in black women
Manios et al., 2008 ²²	Retrospective cohort	Initiation (ever breastfed) and duration until 6 months of age	2,518 women (Greece)	Birthweight, gestational age, parity, smoking, maternal age and education. Gestational weight gain analyzed separately	OB women less likely to initiate BF (OR 2.86, 95% CI 1.74-4.70). No association with maternal prepregnancy BMI and duration of BF
Mok et al., 2008 ²³	Prospective case-control	Initiation (ever breastfed) and duration of BF until 3 months	111 OB mothers with 111 normal weight matched on infant feeding, parity, maternal age, ethnicity, and education (France)	No adjustments	OB mothers less likely to initiate (48% vs. 64%) and maintain EBF at 1 and 3 months. OW (56.8% vs. 64%) also less likely to initiate BF
Oddy et al., 2006 ²⁴	Prospective cohort	Infants followed until 3 years of age (initiation [ever breastfed] and duration of BF)	1,803 (Australia) including Asian and Aboriginal	Smoking in pregnancy, race, age, parity and pregnancy problems (including diabetes and preclampsia) and birth problems (preterm labor, fetal distress) and cesarean section	No difference for initiation but reduced duration of BF for OW and OB mothers at 2, 4, and 6 months of age (HR 1.18, 95% CI 1.05-1.34)

BF, breastfeeding; BMI, body mass index; CI, confidence interval; EBF, exclusive breastfeeding; GA, gestational age; OB, obese; OR, odds ratio; OW, overweight; SES, socioeconomic status; RR, relative risk; HR, hazard ratio.

with insulin had poorer sucking patterns compared to infants of mothers without diabetes, suggesting a newborn's neurological behavior may be affected by maternal diabetes²⁸ and emphasizing the importance of evaluating maternal diabetes in any study that assesses the association between maternal obesity and BF success. Studies from experimental animal models suggest that maternal obesity is associated with different types of metabolic derangements, including a higher insulin response and slower glucose disposal rates, as well as higher fasting insulin concentrations.¹⁵ These changes might be especially pronounced in women who have diabetes that is poorly managed. Other studies have cited the fact that there may be a reduced fall in progesterone (which triggers lactogenesis) during the postpartum period in overweight/obese mothers because progesterone is produced in adipose tissue, although this hypothesis has yet to be proven.¹⁶

The role of extreme maternal BMI category, specifically women who have a BMI ≥ 35 or ≥ 40 , should be further evaluated in future studies, particularly given the rising percentage of women in the United States and internationally who fall into this category.²⁹ Biological data suggest that adipose tissue changes as obesity becomes more severe, with histological changes as well as changes in endocrine and paracrine secretion.³⁰ In the studies reviewed, obese and, in some cases, extremely obese women were more likely to have failure to initiate BF or reduced duration of BF in comparison with overweight or normal weight women. The study by Baker et al.²⁵ found increasingly higher relative risks for higher classes of obesity, as did Liu et al.,²¹ who also found that only extremely obese women (BMI ≥ 35) were more likely to fail to initiate BF.

Future studies should investigate the role of gestational weight gain and the differential impact it may have on women of different BMI categories on BF outcomes. Excess maternal adiposity may interfere with the development of mammary glands at various times (before conception, during pregnancy, and during lactation), although limited data are available on how timing of adiposity gain could impact BF outcomes.³⁰ Some previous studies not included in this review used postpartum BMI,^{31,32} potentially conflating the relationship between maternal BMI category (prepregnancy) and gestational weight gain on BF outcomes. One study evaluated in this review conducted a stratified analysis for gestational weight gain, finding important differences based on BMI category in risk for failure to initiate BF¹⁹; another analyzed gestational weight gain in a separate model because it was so closely correlated with maternal BMI category.²² In the study by Li et al.,²⁰ of underweight and normal weight women, the odds of never initiating BF were lower the greater the gestational weight gain, whereas no such relationship was observed in overweight and obese women. Similarly, gaining less than the recommended weight gain during pregnancy increased the odds of failure to initiate BF in all but the obese women. There may be important factors associated with adiposity gained in pregnancy that could impact lactogenesis and BF rates, in contrast with adiposity that was present before pregnancy; future studies should investigate these possible differences.

Few studies reviewed evaluated the role of maternal behavioral factors on BF success except for the study by Hilson et al.,¹⁶ which comprehensively evaluated BF knowledge and behaviors via survey and observational analysis before hos-

pital discharge. As previous reviews and studies indicate, there are likely behavioral factors that contribute to reduced BF initiation and duration in overweight and obese women, including the choice to breastfeed,³⁰ in addition to the biological or mechanical factors. To better understand the relative contribution of social and psychological factors vs. biological or mechanical factors, future studies must evaluate all these potential pathways to poor BF outcomes.

Conclusions

Overall, this review found an association between higher BMI categories and failure to initiate BF and shorter duration of BF; however, many questions remain about the role of cofactors in mediating this relationship that are important to better understand in structuring interventions. Future studies should evaluate the role that race/ethnicity, gestational diabetes, and other maternal comorbidities, in addition to social and psychological factors, have in impacting BF success and duration. Lastly, studies should carefully consider the timing of adiposity gain (prepregnancy BMI) vs. excessive weight gain in pregnancy in relation to both failure to initiate BF and BF duration. These cofactors likely have important effects on maternal physiology and could also impact maternal and infant behavioral factors.

Similar to other reviews^{14,30} but using a more precise definition of maternal prepregnancy BMI, this review found increased risks for failure to initiate BF and early BF cessation with increased maternal BMI category. However, much future research needs to be conducted to understand the myriad of factors, including medical comorbidities and timing of adiposity gain, to further delineate risk and structure appropriate interventions.

Acknowledgments

The author is supported by NIH grant NIDDK 080825.

Disclosure Statement

The author has no conflicts of interest to report.

References

1. United States Department of Health and Human Services. Healthy people 2010: National health promotion and disease prevention objectives. Washington, DC: U.S. Department of Health Human Services, 2000.
2. American Academy of Pediatrics. Breastfeeding and the use of human milk. *Pediatrics* 2005;115:496–506.
3. Centers for Disease Control and Prevention. Racial and ethnic differences in breastfeeding initiation and duration by state-national immunization survey, United States, 2004–2005. *MMWR* 2010;59:327–334.
4. National Heart, Lung and Blood Institute. Clinical guidelines on the identification, evaluation and treatment of overweight and obesity in adult: The evidence report. *Obes Res* 1998;6:51S–209S.
5. Rasmussen KM, Kjolhede CL. Prepregnant overweight and obesity diminish the prolaction response to suckling in the first week postpartum. *Pediatrics* 2004;113:465–471.
6. Katz KA, Nilsson I, Rasmussen KM. Danish health care providers' perception of breastfeeding difficulty experienced by women who are obese, have large breasts or both. *J Hum Lact* 2010;26:138–147. [Epub November 12, 2009]

7. Hoover KL. Maternal obesity: Problems of breastfeeding with large breasts. *Womens Health Rep* 2008;6:10.
8. Amir LH, Donath S. A systematic review of maternal obesity and breastfeeding intention, initiation and duration. *BMC Pregnancy Childbirth* 2007;7:9.
9. Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM. Prevalence of overweight and obesity in the United States 1999–2001. *JAMA* 2006;295:1549–1555.
10. Caballero B. The global epidemic of obesity: An overview. *Epidemiol Rev* 2007;29:1–5.
11. Donath SM, Amir LH. Maternal obesity and initiation and duration of breastfeeding: Data from the longitudinal study of Australian children. *Matern Child Nutr* 2008;4: 163–170.
12. Jarvie E, Ramsay JE. Obstetric management of obesity in pregnancy. *Semin Fetal Neonatal Med* 2010;15:83–88. [Epub October 31, 2009]
13. Lovelady CA. Is maternal obesity a cause of poor lactation performance? *Nutri Rev* 2005;63:352–355.
14. Grijbovski AM, Yngve A, Bygren LO, Sjöström M. Socio-demographic determinants of initiation and duration of breastfeeding in northwest Russia. *Acta Paediatr* 2005;94: 588–594.
15. Hilson JA, Rasmussen KM, Kjolhede CL. Maternal obesity and breast-feeding success in a rural population of white women. *Am J Clin Nutr* 1997;66:1371–1378.
16. Hilson JA, Rasmussen KM, Kjolhede CL. High prepregnant body mass index is associated with poor lactation outcomes among white, rural women independent of psychosocial and demographic correlates. *J Hum Lact* 2004; 20:18–29.
17. Kehler HL, Chaput KH, Tough SC. Risk factors for cessation of breastfeeding prior to six months postpartum among a community sample of women in Calgary, Alberta. *Can J Public Health* 2009;100:376–380.
18. Kitsantas P, Pawloski LR. Maternal obesity, health status during pregnancy, and breastfeeding initiation and duration. *J Matern Fetal Neonatal Med* 2010;23:135–141.
19. Kugyelka JG, Rasmussen KM, Frongillo EA. Maternal obesity is negatively associated with breastfeeding success among Hispanic but not black women. *J Nutr* 2004;134: 1746–1753.
20. Li R, Jewell S, Grummer-Strawn L. Maternal obesity and breast-feeding practices. *Am J Clin Nutr* 2003;77:931–936.
21. Liu J, Smith MG, Dobre MA, Ferguson JE. Maternal obesity and breast-feeding practices among white and black women. *Obesity*. 2010;18:175–182. [Epub June 11, 2009]
22. Manios Y, Grammatikaki E, Kondaki K, Ioannou E, Anastasiadou A, Biribilis M. The effect of maternal obesity on initiation and duration of breast-feeding in Greece: The GENESIS study. *Public Health Nutr* 2009;12:517–524. [Epub June 12, 2008]
23. Mok E, Multon C, Piguel L, et al. Decreased full breast-feeding, altered practices, perceptions, and infant weight change of prepregnant obese women: A need for extra support. *Pediatrics* 2008;121:e1319–1324.
24. Oddy WH, Li J, Landsborough L, Kendall GE, Henderson S, Downie J. The association of maternal overweight and obesity with breastfeeding duration. *J Pediatr* 2006;149:185–191.
25. Baker JL, Michaelsen KF, Sørensen TI, Rasmussen KM. High prepregnant body mass index is associated with early termination of full and any breastfeeding in Danish women. *Am J Clin Nutr* 2007;86:404–411.
26. Institute of Medicine. Nutrition during pregnancy. Washington, DC: National Academy Press, 1990.
27. Hartmann P, Cregan M. Lactogenesis and the effects of insulin-dependent diabetes mellitus and prematuring. *J Nutr* 2001;131:3016S–3020S.
28. Bromiker R, Rachamim A, Hammerman C, Schimmel M, Kaplan M, Medoff-Cooper B. Immature sucking patterns in infants of mothers with diabetes. *J Pediatr* 2006;149:640–643.
29. Blackburn GL, Wollner S, Heymsfield SB. Lifestyle intervention for the treatment of class III obesity: A primary target for nutrition medicine in the obesity epidemic. *Am J Clin Nutr* 2010;91:289S–292S. [Epub November 11, 2009]
30. Rasmussen KH. Association of maternal obesity before conception with poor lactation performance. *Ann Rev Nutr* 2007;27:103–121.
31. Sebire NJ, Jolly M, Harris JP, et al. Maternal obesity and pregnancy outcome: A study of 287, 213 pregnancies in London. *Int J Obes* 2001;25:1175–1182.
32. Li R, Grummer-Strawn L. Racial and ethnic disparities in breastfeeding among United States infants: Third National Health and Nutrition Examination Survey, 1988–1994. *Birth* 2002;29:251–257.

Address correspondence to:
 Janet M. Wojcicki, Ph.D., M.P.H.
 Department of Pediatrics
 500 Parnassus Avenue MU4E
 University of California, San Francisco
 San Francisco, CA 94134-0136
 E-mail: wojcicki@gmail.com

