Published in final edited form as:

J Hum Lact. 2016 November ; 32(4): 658–665. doi:10.1177/0890334416663196.

Early Lactation and Infant Feeding Practices Differ by Maternal Gestational Diabetes History

Reena Oza-Frank, PhD, RD^{1,2}, Jennifer J. Moreland, PhD¹, Kelly McNamara, MA¹, Sheela R. Geraghty, MD, MS³, and Sarah A. Keim, PhD, MA, MS^{1,2,4}

¹The Research Institute at Nationwide Children's Hospital, Columbus, OH, USA

²The Ohio State University College of Medicine, Columbus, OH, USA

³Cincinnati Children's Hospital Medical Center, Cincinnati, OH, USA

⁴The Ohio State University College of Public Health, Columbus, OH, USA

Abstract

Background: Detailed data on lactation practices by gestational diabetes mellitus (GDM) history are lacking, precluding potential explanations and targets for interventions to improve lactation intensity and duration and, ultimately, long-term maternal and child health.

Objective: This study aimed to examine breastfeeding practices through 12 months postpartum by GDM history.

Methods: Women who delivered a singleton, liveborn infant at The Ohio State University Wexner Medical Center (Columbus, OH), in 2011 completed a postal questionnaire to assess lactation and infant feeding practices and difficulties. Bivariate and multivariate associations between GDM history and lactation and infant feeding practices were examined.

Results: The sample included 432 women (62% response rate), including 7.9% who had GDM during the index pregnancy. Women with GDM initiated breastfeeding (at-the-breast or pumping) as often as women without any diabetes but were more likely to report introduction of formula within the first 2 days of life (79.4% vs 53.8%, $P < .01$; adjusted odds ratio: 3.48; 95% confidence interval, 1.47–8.26). Women with GDM initiated pumping 4 days earlier than women without diabetes ($P < .05$), which was confirmed in adjusted analyses. There was no difference in the proportion of women reporting breastfeeding difficulty (odds ratio: 2.08; 95% confidence interval, 0.78–5.52). However, there was a trend toward women with GDM reporting more formula feeding and less at-the-breast feeding as strategies to address difficulty compared with women without diabetes.

Reprints and permissions: sagepub.com/journalsPermissions.nav

Corresponding Author: Reena Oza-Frank, PhD, RD, Center for Perinatal Research, The Research Institute at Nationwide Children's Hospital, Department of Pediatrics, The Ohio State University, 700 Children's Drive, WB5241, Columbus, OH 43205, USA. reena.oza-frank@nationwidechildrens.org.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Conclusion: Additional research is needed to understand why women with GDM engage in different early lactation and infant feeding practices, and how best to promote and sustain breastfeeding among these women.

Keywords

breastfeeding; breastfeeding and diabetes; diabetes; infant and child nutrition; infant feeding; infant feeding behavior

Background

Gestational diabetes mellitus (GDM) is defined as impaired glucose tolerance with onset, or first recognition, during pregnancy.¹ Considering that women with GDM are more than 7 times more likely to develop type 2 diabetes in their lifetime compared with women without GDM,² breastfeeding is a promotable behavior with direct, relevant health benefits for women with GDM. Specifically, lactation intensity and duration are positively associated with improved postpartum glucose and insulin response^{3–6} and decreased risk of type 2 diabetes.⁷ Infants of mothers with GDM also receive specific benefits from breastfeeding: breast milk can help mitigate effects of hypoglycemia, a common problem among these infants,⁸ and breast milk may also lower future risks for obesity and metabolic syndrome.^{9,10} Although women with GDM initiate breastfeeding at rates similar to,¹¹ or even higher than,¹² women without maternal diabetes, fewer women with GDM continue breastfeeding through 2 months.¹¹

Reasons for these differences in lactation and infant feeding practices by GDM history are just beginning to be explored. Women with GDM report more difficulty in producing enough milk than do women without diabetes,¹¹ which may explain why infants of mothers with GDM receive fluids other than human milk (eg, formula) earlier than the infants of women without diabetes.¹³ Introduction of formula is associated with earlier cessation of breastfeeding among some women.^{14,15} Strategies to maintain and increase milk supply that would address reported difficulty in producing enough milk include more feeding at-the-breast and pumping breast milk.^{16,17} Yet, detailed data on lactation practices by GDM history are lacking, precluding explanations and targets for intervention to improve lactation and, ultimately, long-term maternal health. Therefore, the objective of this study was to examine the following breastfeeding practices by GDM history through 12 months postpartum: at-the-breast feeding, pumping, and formula introduction. We hypothesized that women with GDM would experience different breastfeeding practices, based on sparse previous literature assessing breastfeeding practices by GDM history. A secondary objective was to assess the strategies used by women who reported difficulty in producing sufficient milk to overcome this difficulty by GDM history.

Methods

Study Population

Data came from the Moms2Moms (M2M) Study.¹⁸ The objective of the M2M Study was to examine lactation and infant feeding practices through 12 months postpartum. A

questionnaire was mailed 12 months after delivery to all eligible women who delivered a singleton, live-born infant at > 24 weeks of gestation at The Ohio State University Wexner Medical Center (Columbus, OH) in 2011 (n = 1244 eligible women who delivered during the recruitment period).

Women were eligible if they were English speaking and at least 18 years of age at the time of the survey. Women stating an intention to exclusively bottle feed (n = 303), prisoners (n = 11), infant deaths (n = 6), and those lacking sufficient contact information (n = 111) were excluded from M2M. The Ohio State University Biomedical Institutional Review Board reviewed and approved M2M.

Maternal lactation and infant feeding practices were assessed in the questionnaire by asking mothers to report timing of start and stop of feeding at-the-breast and pumping, introduction of formula and other liquids, and perceptions of low milk supply (Table 1). Responses were used to examine the following primary breastfeeding outcomes: initiation and duration of (1) breastfeeding (combined at-the-breast or pumped milk), (2) at-the-breast feeding, and (3) pumping. Breastfeeding duration was defined as the age of the infant, in days, when the mother completely stopped feeding at-the-breast or pumping milk, minus the age, in days, at breastfeeding initiation. This definition allowed us to estimate the length of time the mother was actually lactating (ie, expending calories producing milk), rather than the infant's human milk consumption duration, which may differ due to feeding of stored milk. We also examined the timing of formula introduction, self-perceived greatest difficulty producing enough breast milk, and how women managed perceived difficulties in producing enough breast milk to satisfy their infant.

Gestational diabetes mellitus history was determined based on *International Classification of Diseases, 9th revision* (ICD-9) codes obtained from maternal medical records; 648.8X was categorized as a GDM diagnosis.¹⁹ If a diagnosis of 250.XX (type 1 or type 2 diabetes) was recorded for a woman who also had a 648.8X diagnosis code documented, then we categorized this woman as having prepregnancy diabetes mellitus. We excluded mothers with either type 1 or type 2 diabetes from analyses (n = 14), as their breastfeeding patterns differ from women with GDM.^{11,12,20}

We obtained the following demographics from questionnaire responses or from the maternal medical record (Table 2): maternal age at delivery, race, education, yearly household income, type of health insurance, participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), partner status, number of previous live births, delivery mode, birth weight, length of newborn hospital stay, work/school status, and infant age when mother returned to work/school (if the mother returned to either or both activities).

Statistical Analysis

Bivariate associations between GDM history and lactation and infant feeding practices were examined. For continuous variables with a normal distribution, means were compared using 2 independent sample *t* tests, median comparisons were made using the Wilcoxon-Mann-Whitney test for nonparametric continuous variables, and chi-square tests were used to make

comparisons between women with GDM and women without diabetes for categorical variables. Multivariable logistic or linear regression models were used for each feeding practice as a separate outcome. When continuous outcomes were not normally distributed, variables were log-transformed, and back-transformed results presented. Confounders included maternal age, race, education, household income, insurance at time of delivery, partner status, and parity. Confounders were selected a priori, based on established associations with GDM (independent variable) and feeding outcomes (dependent variable). Potential confounders with $P < .05$ were retained when considered together with all potential confounders. Multicollinearity was tested using the variance inflation factor (VIF). The Hosmer-Lemeshow test was used to assess the fit of the logistic regression models.

Results

Of the 813 surveys mailed, 501 were returned completed (62% response). Women with prepregnancy diabetes ($n = 7$), preterm infants (< 37 weeks gestation; $n = 53$),²¹ both prepregnancy diabetes and preterm infants ($n = 7$), and unintelligible responses ($n = 2$) were excluded. The final sample included 432 women—92.1% ($n = 398$) without diabetes and 7.9% ($n = 34$) with GDM.

Bivariate analyses of demographic variables showed that women with GDM were more likely to have a household income of \$34 999, receive public insurance at the time of their infant's birth, participate in WIC, and have a cesarean section, and less likely to be partnered (Table 2). There were no differences in maternal age at delivery (30.5 [GDM] vs 30.4 years), infant birth weight (3430.0 vs 3418.5 g), or child age (in days) when the mother went back to work/school 20+ hours per week (median: 84; interquartile range, 56–90 vs 60, 42–90) (data not shown).

Women with GDM initiated breastfeeding (97.1% vs 98.0%, respectively), feeding at-the-breast (93.9% vs 96.7%), and pumping (90.9% vs 91.4%) and ever experienced difficulty producing enough milk (84.9% vs 72.9%) about as often as women without diabetes (Figure 1). However, women with GDM were more likely to feed infants formula within the first 2 days of life (78.8% vs 52.8%, $P < .01$ [Figure 1]; median age at introduction: 1.0 vs 4.0 days [Table 3]; crude odds ratio: 3.32; 95% confidence interval [CI], 1.41–7.82, and adjusted (for parity) odds ratio: 3.48; 95% CI, 4.47–8.26 [data not shown; Hosmer-Lemeshow $P > .10$]).

Mean durations of breastfeeding and pumping did not differ by GDM; however, women with GDM engaged in at-the-breast feeding for fewer days than women without diabetes (152.2 ± 136.7 vs 209.4 ± 137.6 days, $P < .05$) (Figure 2), although this did not remain significant after adjustment (Table 4). Women with GDM initiated pumping significantly sooner than did women without GDM (Table 3), and this relationship remained significant upon adjustment (Table 4). We did not find evidence of multicollinearity; all VIFs were < 2.2 .

We found no differences in the proportions of women reporting difficulty producing enough milk (84.9% GDM vs 72.9% without GDM; odds ratio [no confounders were significant]: 2.08; 95% CI, 0.78–5.52 [data not shown; Hosmer-Lemeshow $P > .10$]). Of women who reported breast milk production issues, mothers most frequently chose to feed their infant,

pump breast milk, and feed their infant food. Women with GDM less often reported increasing feeding at-the-breast than did women without diabetes, to address perceived low milk supply (Table 5). However, none of these differences were significant. We observed no difference in infant age when reported difficulty began (data not shown); however, there was a significant, positive association between when difficulty producing enough milk began and when pumping began among women without GDM ($r = 0.32$; $P < .01$) but not among women with GDM ($r = 0.24$; $P = .20$).

Discussion

This is the first study to describe detailed lactation and infant feeding practices by GDM history. Among women who gave birth to term infants, women with GDM reported initiating pumping and fed their infants formula sooner than did women without diabetes. In this study, early pumping initiation and formula introduction was unrelated to breastfeeding duration. However, our data indicate a trend toward shorter overall breastfeeding duration among women with GDM. Furthermore, many of the unadjusted associations we observed in infant feeding practices by GDM were attenuated or eliminated upon adjustment, indicating that differences may be more strongly associated with demographic factors. Prior research shows that GDM history is associated with demographic characteristics (eg, socioeconomic status, race/ethnicity, etc),^{22,23} which are also related to breastfeeding.^{24,25} Addressing the demographic barriers associated with breastfeeding, then, should also address the barriers experienced by women with GDM history.

We hypothesized that women with GDM would experience differences in breastfeeding practices compared with women without diabetes. This hypothesis was based on previous literature indicating differences in breastfeeding initiation and continuation by diabetes history¹¹ and previous work indicating that women with GDM are more likely to introduce formula during delivery hospital stay compared with women without GDM.¹³ We confirmed this latter finding and extended these previous results by describing earlier pumping initiation. No other study has described these breastfeeding practices by GDM history.

Results of our study echo findings that women with GDM may not continue breastfeeding even after initiating breastfeeding.²⁶ Our study showed that more than 75% of women with GDM reported that their infants were fed formula within the first 2 days of life, despite recommendations to exclusively breastfeed for 6 months.^{27,28} Research demonstrates that among women who initiate breastfeeding, introduction of formula is typically associated with shorter duration of breastfeeding, compared to exclusively breastfed infants.¹⁴ Strategies that increase breastfeeding duration and delay formula initiation should be considered to mitigate this risk. Even if formula is temporarily used for medical reasons (eg, to treat jaundice²⁹ or hypoglycemia,³⁰ delayed lactogenesis,³¹ perceived low milk supply³²), breastfeeding intensity (proportion of feeds that are breast milk) can be resumed after the medical need for formula has passed.¹⁵ Mothers may not know that they have choices with regard to formula introduction during hospital stay and/or may not know that formula use can be temporary. The medical necessity for formula introduction during hospital stay has been questioned,³³ yet it is a strategy to help mothers overcome temporary breastfeeding issues.^{15,34,35}

Despite differences in lactation and infant feeding practices, earlier pumping initiation did not necessarily affect pumping duration by GDM history. This finding is contrary to previous work indicating that breast milk pumping was associated with a shorter breastfeeding duration.^{36,37} Although breast milk pumping is becoming more common,^{38,39} it is unknown whether or not expressed milk provides the same benefit as milk fed directly at-the-breast. Benefits of at-the-breast feeding have been identified⁴⁰ and women with GDM should be encouraged to engage in this behavior for several reasons. First, both at-the-breast feeding and pumping can maintain and increase milk supply, particularly for women with reported difficulty producing enough milk.¹⁷ Our data indicate that almost 12% more women with GDM reported difficulty producing enough milk compared with women without diabetes. Because women with GDM do not appear to be engaging in both practices for as long as women without diabetes, this may affect milk supply and ultimately facilitate earlier breastfeeding cessation. Both practices should be encouraged to maximize milk production potential.¹⁷

Physiologically, women with GDM are more likely to be overweight or obese than women without diabetes,⁴¹ and higher prepregnancy weight may contribute to delayed lactogenesis^{31,42,43} and earlier pumping initiation. Prepregnancy weight was not collected in the current study, so the effect of obesity on breastfeeding outcomes could not be assessed. Furthermore, although the timing of “milk coming in” was not asked in the survey, and there was no significant difference in the timing of reported greatest difficulty by GDM, unadjusted data show that women with GDM reported difficulty almost 16 days earlier than women without diabetes. We did not find an association between reported difficulty in producing enough milk and pumping initiation in women with GDM. However, results demonstrate an association among women without diabetes, indicating that women with GDM pumped breast milk independent of any reported difficulty.

Although previous research showed no differences in mothers’ reported reasons for discontinuing feeding breast milk by GDM history,¹¹ our results indicate potential important differences in strategies to overcome reported difficulty producing enough milk. Women with GDM more often reported pumping rather than feeding at-the-breast and their infants were more often fed formula within the first 2 days of life. We speculate that because women with GDM initiated pumping earlier than women without diabetes, pumping continued to be their preferred strategy over feeding at-the-breast. It is important that women with GDM are educated on the benefits of both behaviors, particularly because research suggests that at-the-breast feeding may encourage feeding self-regulation.⁴⁴ Self-regulation may be especially important for the infant of the woman with GDM history, given that these infants are at increased risk for future overweight/obesity.⁴⁵

A few limitations are noteworthy. First, the subset of women with GDM in this sample is small and results may not be generalizable to all women with GDM history; yet, the prevalence of GDM in the study was reflective of GDM prevalence in the US population.⁴⁶ Second, the survey excluded women who intended to exclusively bottle feed, indicating that the sample is more representative of women who intended to engage in some breastfeeding. In addition, compared with nonresponders, our sample was more educated and more respondents were younger, reported private health insurance, were non-Hispanic white, and

reported fewer (if any) children.¹⁸ The study was not powered to test for differences by GDM history; thus, we were limited to post-hoc analyses likely underpowered to detect small differences in all outcomes. However, differences in unadjusted results are clinically relevant. Furthermore, our *R*-squared values from our regression results were low (~ 0.04), indicating that our data likely contain a higher amount of unexplained variability, which is common in an exploratory study such as this. Finally, we did not have information on level of glycemic control among women with GDM (eg, diet vs insulin controlled disease status), which has implications for breastfeeding outcomes.⁴⁷

However, this study presents several strengths. Examining GDM independently of type 1 or type 2 diabetes provides information on how to specifically promote breastfeeding among these women. Our results were strengthened by the use of detailed maternal self-reported questionnaire data linked to maternal medical records data. Finally, the Moms2Moms Study is unique in that detailed questions were included to ask women how milk was provided to gain a better understanding of whether or not women provide milk only at-the-breast. How milk is provided allows a better understanding of methods used to inform and tailor messages to promote and support breastfeeding.

Conclusion

Our results provide preliminary insights into specific intervention opportunities for improving breastfeeding among women with GDM. Specifically, these women may benefit from receiving education on the importance of engaging in both at-the-breast feeding and pumping to maintain and increase milk supply. The combination of at-the-breast feeding and pumping may increase milk supply, reduce risk for eventual early cessation of exclusive or any breastfeeding, and further contribute to improving postpartum metabolic health. Additional research is needed to determine if women with GDM perceive feeding pumped breast milk as equivalent to at-the-breast feeding, consider 1 behavior to be more convenient than the other, or simply prefer the flexibility of bottle feeding (pumped milk or formula).³⁸ Findings of such research would provide insights into mothers' motivation(s) for engaging in various lactation and infant feeding practices for the development of future interventions aimed at improving breastfeeding duration and exclusivity.

Acknowledgments

The authors thank the women who participated in the Moms2Moms Study and Kendra Heck and Kamma Smith of Nationwide Children's Hospital for administrative support. They also thank Katherine Strafford, Chelsea Dillon, and Rachel Ronau.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: The project was supported by internal funds of The Research Institute at Nationwide Children's Hospital, by grant K23ES14691 from the National Institutes of Health, and by grant UL1TR001070 from the National Center for Advancing Translational Sciences.

References

1. American Diabetes Association. Standards of medical care in diabetes—2015. *Diabetes Care*. 2015;38(suppl 1):S1–S93.

2. Bellamy L, Casas JP, Hingorani AD, Williams D. Type 2 diabetes mellitus after gestational diabetes: a systematic review and meta-analysis. *Lancet*. 2009;373(9677):1773–1779. [PubMed: 19465232]
3. Chouinard-Castonguay S, Weisnagel SJ, Tchernof A, Robitaille J. Relationship between lactation duration and insulin and glucose response among women with prior gestational diabetes. *Eur J Endocrinol*. 2013;168(4):515–523. [PubMed: 23302255]
4. Trout KK, Averbuch T, Barowski M. Promoting breastfeeding among obese women and women with gestational diabetes mellitus. *Curr Diab Rep*. 2011;11(1):7–12. [PubMed: 21052873]
5. Borgono CA, Retnakaran R. Higher breastfeeding intensity associated with improved postpartum glucose metabolism in women with recent gestational diabetes. *Evid Based Med*. 2012;17(6):e7. [PubMed: 22461569]
6. Gunderson EP, Jacobs DR, Jr, Chiang V, et al. Duration of lactation and incidence of the metabolic syndrome in women of reproductive age according to gestational diabetes mellitus status: a 20-year prospective study in CARDIA (Coronary Artery Risk Development in Young Adults). *Diabetes*. 2010;59(2):495–504. [PubMed: 19959762]
7. Gunderson EP, Hurston SR, Ning X, et al. Lactation and progression to type 2 diabetes mellitus after gestational diabetes mellitus: a prospective cohort study. *Ann Intern Med*. 2015;163(12):889–898. [PubMed: 26595611]
8. Chertok IR, Raz I, Shoham I, Haddad H, Wiznitzer A. Effects of early breastfeeding on neonatal glucose levels of term infants born to women with gestational diabetes. *J Hum Nutr Diet*. 2009;22(2):166–169. [PubMed: 19226355]
9. Mayer-Davis EJ, Rifas-Shiman SL, Zhou L, Hu FB, Colditz GA, Gillman MW. Breast-feeding and risk for childhood obesity: does maternal diabetes or obesity status matter? *Diabetes Care*. 2006;29(10):2231–2237. [PubMed: 17003298]
10. Crume TL, Ogden LG, Mayer-Davis EJ, et al. The impact of neonatal breast-feeding on growth trajectories of youth exposed and unexposed to diabetes in utero: the EPOCH Study. *Int J Obes*. 2012;36(4):529–534.
11. Oza-Frank R, Chertok I, Bartley A. Differences in breastfeeding initiation and continuation by maternal diabetes status. *Public Health Nutr*. 2015;18(4):727–735. [PubMed: 24809929]
12. Kachoria R, Oza-Frank R. Differences in breastfeeding initiation by maternal diabetes status and race, Ohio 2006–2011. *Matern Child Health J*. 2014;18(9):2226–2235. [PubMed: 24682646]
13. Haile ZT, Oza-Frank R, Azulay Chertok IR, Passen N. Association between history of gestational diabetes and exclusive breastfeeding at hospital discharge. *J Hum Lact*. 2016;32(3):NP36–NP43. [PubMed: 26590178]
14. Hornell A, Hofvander Y, Kylberg E. Solids and formula: association with pattern and duration of breastfeeding. *Pediatrics*. 2001;107(3):E38. [PubMed: 11230619]
15. Flaherman VJ, Aby J, Burgos AE, Lee KA, Cabana MD, Newman TB. Effect of early limited formula on duration and exclusivity of breastfeeding in at-risk infants: an RCT. *Pediatrics*. 2013;131(6):1059–1065. [PubMed: 23669513]
16. Morton J, Hall JY, Wong RJ, Thairu L, Benitz WE, Rhine WD. Combining hand techniques with electric pumping increases milk production in mothers of preterm infants. *J Perinatol*. 2009;29(11):757–764. [PubMed: 19571815]
17. Kent JC, Prime DK, Garbin CP. Principles for maintaining or increasing breast milk production. *J Obstet Gynecol Neonatal Nurs*. 2012;41(1):114–121.
18. Keim SA, McNamara KA, Dillon CE, et al. Breastmilk sharing: awareness and participation among women in the Moms2Moms Study. *Breastfeed Med*. 2014;9(8):398–406. [PubMed: 25007386]
19. Bryson CL, Ioannou GN, Rulyak SJ, Critchlow C. Association between gestational diabetes and pregnancy-induced hypertension. *Am J Epidemiol*. 2003;158(12):1148–1153. [PubMed: 14652299]
20. Kachoria R, Oza-Frank R. Factors associated with breastfeeding at discharge differ by maternal diabetes type. *Diabet Med*. 2014;31(10):1222–1229. [PubMed: 24654691]
21. Callen J, Pinelli J. A review of the literature examining the benefits and challenges, incidence and duration, and barriers to breastfeeding in preterm infants. *Adv Neonatal Care*. 2005;5(2):72–88. [PubMed: 15806448]

22. Berkowitz GS, Roman SH, Lapinski RH, Alvarez M. Maternal characteristics, neonatal outcome, and the time of diagnosis of gestational diabetes. *Am J Obstet Gynecol.* 1992;167(4, pt 1):976–982. [PubMed: 1415436]
23. Berkowitz GS, Lapinski RH, Wein R, Lee D. Race/ethnicity and other risk factors for gestational diabetes. *Am J Epidemiol.* 1992;135(9):965–973. [PubMed: 1595695]
24. Heck KE, Braveman P, Cubbin C, Chavez GF, Kiely JL. Socioeconomic status and breastfeeding initiation among California mothers. *Public Health Rep.* 2006;121(1):51–59.
25. Kitsantas P, Gaffney KF, Kornides ML. Prepregnancy body mass index, socioeconomic status, race/ethnicity and breastfeeding practices. *J Perinat Med.* 2012;40(1):77–83.
26. Oza-Frank R, Bartley A. Exclusive breastfeeding rates lowest among women with gestational diabetes In: American Diabetes Association 74th Scientific Sessions Vol 63 San Francisco, CA; 2014.
27. World Health Organization. The World Health Organization's infant feeding recommendation. http://www.who.int/nutrition/topics/infantfeeding_recommendation/en/. Accessed May 18, 2016.
28. Eidelman AI, Schanler RJ, Johnston M, et al. Breastfeeding and the use of human milk. *Pediatrics.* 2012;129(3):E827–E841. [PubMed: 22371471]
29. Farrar D, Duley L, Lawlor DA. Different strategies for diagnosing gestational diabetes to improve maternal and infant health. *Cochrane Database Syst Rev.* 2011;(10):CD007122.
30. Kim C Gestational diabetes: risks, management, and treatment options. *Int J Womens Health.* 2010;2:339–351. [PubMed: 21151681]
31. Matias SL, Dewey KG, Quesenberry CP, Jr, Gunderson EP. Maternal prepregnancy obesity and insulin treatment during pregnancy are independently associated with delayed lactogenesis in women with recent gestational diabetes mellitus. *Am J Clin Nutr.* 2014;99(1):115–121. [PubMed: 24196401]
32. Riddle SW, Nommsen-Rivers LA. A case control study of diabetes during pregnancy and low milk supply. *Breastfeed Med.* 2016;11(2):80–85. [PubMed: 26859784]
33. Chantry CJ, Dewey KG, Pearson JM, Wagner EA, Nommsen-Rivers LA. In-hospital formula use increases early breastfeeding cessation among first-time mothers intending to exclusively breastfeed. *J Pediatr.* 2014;164(6):1339–1345. [PubMed: 24529621]
34. Bass JL. In-hospital formula use and early breastfeeding cessation: association not causation. *J Pediatr.* 2015;166(1):209.
35. Korhonen K, Lehtonen L. Unnecessary and necessary in-hospital formula supplementation. *J Pediatr.* 2014;165(4):877.
36. Win NN, Binns CW, Zhao Y, Scott JA, Oddy WH. Breastfeeding duration in mothers who express breast milk: a cohort study. *Int Breastfeed J.* 2006;1:28. [PubMed: 17184553]
37. Felice JP, Cassano PA, Rasmussen KM. Pumping human milk in the early postpartum period: its impact on long-term practices for feeding at the breast and exclusively feeding human milk in a longitudinal survey cohort. *Am J Clin Nutr.* 2016;103(5):1267–1277. [PubMed: 27009751]
38. Team V, Ryan K. Expressed breast milk as commodity: disembodied motherhood and involved fatherhood. 2014:221–235.
39. Chapman DJ. New insights into the risk of feeding infants by bottle. *J Hum Lact.* 2012;28(4):455–456. [PubMed: 23087195]
40. Jansen J, de Weerth C, Riksen-Walraven M. Breastfeeding and the mother–infant relationship—a review. *Dev Rev.* 2008;28(4):503–521.
41. Torloni MR, Betran AP, Horta BL, et al. Prepregnancy BMI and the risk of gestational diabetes: a systematic review of the literature with meta-analysis. *Obes Rev.* 2009;10(2):194–203. [PubMed: 19055539]
42. Brownell E, Howard CR, Lawrence RA, Dozier AM. Delayed onset lactogenesis II predicts the cessation of any or exclusive breastfeeding. *J Pediatr.* 2012;161(4):608–614. [PubMed: 22575242]
43. Rasmussen KM, Hilson JA, Kjolhede CL. Obesity may impair lactogenesis II. *J Nutr.* 2001;131(11):3009s–3011s. [PubMed: 11694637]

44. Li R, Fein SB, Grummer-Strawn LM. Do infants fed from bottles lack self-regulation of milk intake compared with directly breastfed infants? *Pediatrics*. 2010;125(6):e1386–e1393. [PubMed: 20457676]
45. Nilsson C, Carlsson A, Landin-Olsson M. Increased risk for overweight among Swedish children born to mothers with gestational diabetes mellitus. *Pediatr Diabetes*. 2014;15(1):57–66. [PubMed: 23890345]
46. DeSisto CL, Kim SY, Sharma AJ. Prevalence estimates of gestational diabetes mellitus in the United States, Pregnancy Risk Assessment Monitoring System (PRAMS), 2007–2010. *Prev Chronic Dis*. 2014;11.
47. Taylor JS, Kacmar JE, Nothnagle M, Lawrence RA. A systematic review of the literature associating breastfeeding with type 2 diabetes and gestational diabetes. *J Am Coll Nutr*. 2005;24(5):320–326. [PubMed: 16192255]

Well Established

Lactation is positively associated with decreased risk of type 2 diabetes after gestational diabetes mellitus (GDM) pregnancy. Because detailed data on lactation practices by GDM history are lacking, explanations for intervention have yet to be identified.

Newly Expressed

Women with GDM reported initiating pumping and their infants were fed formula earlier than women without diabetes. Education on the importance of supporting both at-the-breast feeding and pumping to maintain and increase milk supply may prolong breastfeeding duration.

Figure 1. Maternal Lactation and Infant Feeding Practices by Gestational Diabetes History, Moms2Moms Study, Ohio, 2011–2012.

Figure 2.
Mean Duration of Maternal and Infant Feeding Practices by Gestational Diabetes History,
Moms2Moms Study, Ohio, 2011–2012.

Table 1.

Survey Questions, Moms2Moms Study, Ohio, 2011–2012.

Timing of Start and Stop of Feeding At-The-Breast and Pumping	Introduction of Formula and Other Liquids	Perceptions of Low Milk Supply
How old was your child when he/she was first fed your breast milk (including directly at the breast or pumped milk)?	How old was your child when he/she was first fed formula (even if it was just 1 time)?	When after delivery did you have the most difficulty in making enough breast milk to feed your child?
How old was your child when he/she was no longer fed your breast milk (either directly at your breast or pumped milk)?	How old was your child when he/she was no longer fed formula?	What did you do when you did not make enough breast milk to feed your child? (a list was provided with the option to write in additional text)
How old was your child when you first directly breastfed him/her at your breast?	How old was your child when he/she was first fed juice or water?	
How old was your child when you stopped directly breastfeeding him/her at your breast?		
How old was your child when he/she was first fed any of your pumped breast milk?		
How old was your child when he/she was no longer fed any of your pumped breast milk?		

Table 2.

Demographics by Gestational Diabetes History, Moms2Moms Study, Ohio, 2011–2012.

Variable	No Diabetes (n = 398), No. (%)	Gestational Diabetes (n = 34), No. (%)	χ^2	P Value
Maternal race			5.0	.08
African/African American/Black	36 (9.1)	7 (20.6)		
White/Caucasian	323 (81.2)	23 (67.7)		
Other	39 (9.8)	4 (11.8)		
Maternal education high school diploma/GED (vs > high school diploma/GED)	36 (9.1)	6 (17.7)	2.6	.10
Household income \$34 999 (vs \$35 000)	101 (25.5)	17 (50.0)	9.4	< .01
Public insurance at delivery (vs private) ^a	67 (16.9)	11 (32.4)	5.1	< .05
Participation in the Special Supplemental Nutrition Program for Women, Infants, and Children				
Partnered (vs single)	359 (90.7)	27 (79.4)	4.3	< .05
Primiparous (vs multiparous) ^a	202 (50.8)	14 (41.2)	1.1	.28
Cesarean section (vs vaginal delivery) ^a	137 (36.2)	18 (56.3)	5.0	< .05
Length of newborn hospital stay > 2 days (vs ≤ 2 days)	170 (42.7)	19 (55.9)	2.2	.14
Mother return to work/school 20+ hours/week since infant's birth	274 (69.0)	23 (67.7)	0.02	.87

* $P < .05$.^aBased on data abstracted from the medical record.

Table 3.

Infant Age in Days of Initiation of Maternal and Infant Feeding Practices by Gestational Diabetes History, Moms2Moms Study, Ohio, 2011–2012.^a

Variable	No Diabetes (n = 398)	Gestational Diabetes (n = 34)	P Value
At-the-breast, median (IQR)	1.0 (1–1)	1.0 (1–1)	.22
Pumping, median (IQR)	7.0 (2–21)	3.0 (1–14)	< .05
Formula feeding, median (IQR)	4.0 (1–90)	1.0 (1–2)	< .01

Abbreviation: IQR, interquartile range.

^aEach comparison by diabetes status was made using the Wilcoxon-Mann-Whitney test.

* $P < .05$.

Table 4.

Multivariable Linear Adjusted Associations of Maternal Lactation and Infant Feeding Practices and Gestational Diabetes History, Moms2Moms Study, Ohio, 2011–2012 (N = 432).

	β Coefficient, d			
	Crude	P Value	Adjusted	P Value
Breastfeeding (at-the-breast or pumping), duration ^a	−39.10	.10	−21.04	.37
At-the-breast feeding ^b				
Duration	−57.28	.02	−37.13 ^c	.15
Infant age at initiation ^d	1.41	.10	1.33 ^e	.16
Pumping ^f				
Duration	−26.32	.22	−10.42 ^g	.62
Infant age at initiation ^d	0.30	.05	0.23 ^h	<.05

^a Among women who initiated breastfeeding, adjusted for maternal age at delivery and type of insurance.

^b Among women who ever reported feeding at-the-breast.

^c Among women who ever reported feeding at-the-breast, adjusted for maternal age at delivery and type of insurance.

^d Among women who ever reported feeding at-the-breast; outcome was log-transformed.

^e Among women who ever reported feeding at-the-breast, adjusted for maternal race, type of insurance, and parity.

^f Among women who ever reported pumping.

^g Among women who ever reported pumping, adjusted for type of insurance.

^h Among women who ever reported pumping, adjusted for maternal age at delivery and education.

Table 5.

Strategies to Overcome Reported Difficulty of Not Producing Enough Milk by Gestational Diabetes History, Moms2Moms Study, Ohio, 2011–2012.^a

	No Diabetes (n = 398)	Gestational Diabetes (n = 34)
Fed infant formula	78.8%	89.3%
Pumped breast milk	58.3%	60.7%
Fed infant at-the-breast more	42.4%	35.7%
Took herbal supplements	28.5%	21.4%
Fed infant food	8.3%	10.7%
Changed diet	5.2%	3.4%
Fed infant less than usual	1.7%	0
Added water to breast milk	0.4%	0

^aOnly women reporting difficulty producing enough milk (n = 316) were included; women could select more than 1 answer choice.