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## Adherence to Breastfeeding Guidelines and Maternal Weight 6 Years After Delivery

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### Abstract

**OBJECTIVES**—There is a dearth of information on the long-term maternal effects of breastfeeding. The objective of this study was to examine adherence to breastfeeding recommendations of exclusive breastfeeding for 4 months and continuation of breastfeeding for 1 year and maternal weight retention 6 years after delivery.

**METHODS**—Using data from the Infant Feeding Practices Study II (IFPS II), we categorized women by the degree to which they met breastfeeding recommendations. Mothers' self-reported weight 6 years after delivery (IFPS Year 6 Follow-Up) was compared with self-reported prepregnancy weight from IFPS II. Using linear regression models, adjusting for covariates, we examined associations between breastfeeding recommendation adherence and weight retention.

**RESULTS**—Of the 726 women in our study, 17.9% never breastfed. Among those who initiated breastfeeding, 29.0% breastfed exclusively for 4 months, and 20.3% breastfed exclusively for 4 months and continued breastfeeding for 12 months. Prepregnancy BMI modified the association between breastfeeding recommendation adherence and weight retention. Adjusting for covariates, we found no association between breastfeeding recommendations adherence and weight retention among normal and overweight mothers. Among obese mothers, there was a significant linear trend ( $P = .03$ ), suggesting that those who fully adhered to breastfeeding recommendations retained less weight (−8.0 kg) than obese women who never breastfed.

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**CONCLUSIONS**—This study suggests that improving adherence to breastfeeding recommendations may help reduce long-term maternal weight retention among obese mothers. Larger studies, with diverse populations and similar longitudinal designs, are needed to explore this relationship.

### Keywords

breastfeeding; benefits; maternal weight; human milk; exclusivity; duration

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Maternal overweight and obesity, as measured by BMI, are associated with adverse health outcomes for women,<sup>1–3</sup> including cardiovascular disease<sup>4</sup> and breast cancer.<sup>5</sup> The prevalence of overweight and obesity in the United States is high, with approximately half of all women aged 25 to 55 years being overweight or obese.<sup>6</sup> Although many factors influence women's weight throughout adulthood, findings from studies examining the association between breastfeeding and postpartum weight retention have been mixed.<sup>7,8</sup> Discrepant findings probably result from varying study definitions of breastfeeding, including attributes such as exclusivity (ie, giving a child only breast milk and no other liquids or solids<sup>9</sup>), duration (ie, the amount of time a mother breastfeeds or gives breast milk to her child, usually referring to giving any amount of breast milk<sup>9</sup>), and intensity (ie, the percentage of milk feedings including breast milk<sup>10</sup>). Discrepant findings may also be attributed to rigor of the study design, chosen postpartum measurements, and length of the follow-up period.<sup>7</sup>

Breastfeeding is an important public health issue. Children who are breastfed have protection against infection<sup>11–14</sup> and sudden infant death syndrome<sup>15</sup> and lower risk of a number of chronic diseases,<sup>16,17</sup> including obesity.<sup>18–20</sup> Mothers who breastfeed have a lower risk for type 2 diabetes,<sup>21,22</sup> hypertension,<sup>23</sup> and breast<sup>24,25</sup> and ovarian cancers.<sup>26,27</sup> Effects of breastfeeding on long-term maternal weight are less understood, however.

It is estimated that exclusive lactation requires an approximate daily energy expenditure of 2100 kJ<sup>28</sup>; thus, compared with nonbreastfeeding women, those who breastfeed may have an advantage in terms of postpartum weight loss.<sup>29</sup> Although many studies indicate that extended duration of breastfeeding may decrease maternal weight retention in the first year postpartum,<sup>7</sup> few have examined the influences of lactation-related energy expenditure associated with breastfeeding duration, exclusivity, and intensity on weight retention >1 year postpartum.

The objective of this study was to examine the influence of adherence to the 2005 American Academy of Pediatrics (AAP) recommendations<sup>30</sup> for breastfeeding duration and exclusivity with maternal weight 6 years postpartum. We hypothesized that women who adhered to the AAP recommendations would have lower weight retention 6 years postpartum compared with women who did not adhere to recommendations.

## METHODS

### Participants and Data Collection

We analyzed data from the 2005–2007 Infant Feeding Practices Study II (IFPS II) and the IFPS II Year 6 Follow-Up (Y6FU). Detailed descriptions of IFPS II<sup>31</sup> and Y6FU<sup>32</sup> are provided elsewhere. Briefly, during IFPS II, mothers completed a questionnaire during the last trimester of pregnancy and were asked to complete 10 additional questionnaires throughout the first year postpartum. The questionnaire included items on maternal health, infant health and feeding, and other related topics; they were completed approximately monthly during the first 7 months of infant age and then approximately every 7 weeks until the infant was 12 months old. Six years later, mothers completed an additional questionnaire as part of the Y6FU. Because we have comprehensive breastfeeding data only for infants from IFPS II, we limited our analysis to women who had no additional births after participating in IFPS II ( $n = 853$ ).

### Measures and Variables

The main outcome variable was calculated as the difference between mother's self-reported weight collected at the Y6FU and her self-reported prepregnancy weight collected in the last trimester of pregnancy. Although any weight gained or lost during this period could reflect weight changes associated with pregnancy or weight changes after breastfeeding, we refer to this measure as weight retention.

Breastfeeding behaviors were assessed via the 10 postpartum IFPS II questions. Breastfeeding duration was defined as the age of the infant in weeks when the mother completely stopped breastfeeding or pumping milk, rather than the age at which the child stopped receiving breast milk (eg, stored breast milk). This definition enabled us to estimate the length of time the mother was lactating and therefore expending calories producing milk. Breastfeeding duration data were obtained from IFPS II unless a participant indicated she was still breastfeeding when she completed her last IFPS II questionnaire. For women who reported they were still breastfeeding at the time they completed their last IFPS II questionnaire, we used the breastfeeding duration data reported in Y6FU ( $n = 144$ ). If that information was not provided, we used the last known age at which the child was breastfeeding during IFPS II ( $n = 23$ ). In each IFPS II questionnaire, mothers were asked to estimate the average number of feedings of foods or liquids, including formula and other types of milk (breast milk, cow's milk, and other milks), that their infant received in the preceding 7 days. Duration of exclusive breastfeeding was calculated as the infant's age at the midpoint between the last questionnaire when the mother reported feeding only breast milk and the first questionnaire when a food or liquid other than breast milk was introduced.

We used the breastfeeding duration and exclusivity data to create our exposure variable based on meeting the 2005 AAP breastfeeding recommendations,<sup>30</sup> which include exclusive breastfeeding for 4 months and continued breastfeeding for 12 months. Although the AAP released new guidelines in 2012,<sup>33</sup> at the time IFPS II data were collected, the 2005 recommendations were in place. The 2005 recommendations stated that exclusive breastfeeding was sufficient for “approximately the first 6 months of life”; however, the

statement goes on to specify that some infants might need complementary foods to be added to their diets “as early as 4 months of age.” Thus, we used the conservative measure of exclusive breastfeeding for 4 months. The exposure variable was categorized as never breastfed (reference group); initiated breastfeeding but did not exclusively breastfeed for 4 months; met exclusivity recommendation, but breastfeeding duration was <12 months; and met recommendations for exclusivity, and breastfeeding duration was 12 months.

Our study objective was to use adherence to AAP breastfeeding recommendations as a proxy for lactation-related maternal energy expenditure; the more recommendations met, the higher the lactation-related energy expenditure. We assumed that women who met the AAP recommendations were giving only breast milk as their infant’s milk source during the 12-month period. To examine this assumption, we estimated mean breast milk intensity using data from the questionnaires for months 5 through 10.5.

Breastfeeding intensity was estimated for each month based on the mother’s recall of all milk the infant received and the percentage that was breast milk. Additional details on calculation of breastfeeding intensity are provided elsewhere.<sup>10</sup> Intensity data from the month 12 questionnaire were not included because the majority of mothers completed this questionnaire after the infant was 12 months old, and they reported they had already introduced cow’s milk to their children’s diets. Forty mothers who fed their infants breast milk exclusively for 4 months and breastfed 12 months also introduced infant formula or another breast milk alternative between 5 and 10.5 months. Thus, for these women, their mean breast milk intensity during those months was <100%. We categorized these women as meeting both the exclusivity and 12-month duration recommendations; however, to account for possible misclassification of lactation-related energy expenditure, we conducted a sensitivity analysis where we excluded the women with mean breast milk intensity from 5 to 10.5 months of <95%. This cutoff point was chosen based on inspection of intensity data for months 5, 6, 7, and 10.5. Women with a breast milk intensity of <95% typically added a breast milk alternative for 2 months, whereas women with 95% to 99% added a breast milk alternative for only 1 month.

Mother’s age, race or ethnicity, education, income, marital status, parity, and gestational weight gain were self-reported during IPFS II. We calculated prepregnancy BMI using IPFS II data on self-reported weight and height and categorized mothers as normal weight (BMI <25), overweight (BMI 25 to <30), or obese (BMI 30). From the Y6FU, we used data on mothers’ reports of their current smoking status and physical activity behaviors. Specifically, participants self-reported the average number of cigarettes smoked per day, and these data were analyzed dichotomously (1 cigarette per day = smoker). Leisure time physical activity was self-reported for a usual week, including information on frequency, intensity, and duration. Mothers were categorized as sedentary if they reported engaging in no physical activity. Mothers who reported engaging in physical activity were categorized as meeting physical activity recommendations if they reported engaging in 75 minutes per week of vigorous physical activity, 150 minutes per week of moderate physical activity, or an equivalent combination (moderate + 2 \* vigorous 150 minutes/week).<sup>34</sup>

## Analytic Plan

We performed a complete-subject analysis and excluded participants lacking weight ( $n = 26$ ), sufficient breastfeeding ( $n = 2$ ), or covariate data ( $n = 101$ ). Breastfeeding data were considered insufficient if we could not categorize the mother according to our exposure definitions. Missing data on physical activity or education accounted for nearly 75% of all missing covariate data. Using analysis of variance for continuous variables and  $\chi^2$  statistics for categorical variables, we compared the characteristics of the study sample with those excluded, and we compared characteristics of the study sample by adherence to breastfeeding recommendations. To examine the association between adherence to breastfeeding recommendations and weight retention 6 years after delivery, we used linear regression models adjusting for covariates. Because gestational weight gain and postpartum weight loss patterns may vary by prepregnancy BMI and because prepregnancy weight may affect breastfeeding initiation and duration,<sup>35</sup> we evaluated effect modification by prepregnancy BMI by including an interaction term between prepregnancy BMI and breastfeeding adherence in the model. As previously described, we performed a sensitivity analysis excluding 17 women whose category of fully adhering to both breastfeeding recommendations may have misclassified their lactation-related energy expenditure. We hypothesized that associations between adherence and weight retention would become stronger in the sensitivity analysis.  $P$  values were considered significant at  $<.05$  for main effects and  $<.15$  for interactions. Linear trends were assessed by using a contrast statement. All analyses were conducted by using Statistical Analysis Software version 9.3 (SAS Institute, Inc, Cary, NC).

## RESULTS

Of 853 eligible women, 127 were excluded because of missing data. Compared with those included in the analysis, a smaller proportion of excluded women initiated breastfeeding (74.0% vs 82.1%,  $P = .03$ ) and were married (57.5% vs 84.4%,  $P < .0001$ ), and a larger proportion had a high school education or less (24.2% vs 15.0%,  $P = .02$ ) and were of a race or ethnicity other than white (27.6% vs 13.6%,  $P < .0001$ ). There were no significant differences in the proportion meeting breastfeeding recommendations among those who initiated breastfeeding or in mean weight retention 6 years after delivery (data not shown).

Characteristics of the study sample are provided in Table 1. Of the 726 women included in our analyses, 82.1% initiated breastfeeding. Of those who initiated, 29.0% breastfed exclusively for 4 months, and 20.3% breastfed exclusively for 4 months and continued breastfeeding for 12 months. Among women who adhered to 1 or both components of the breastfeeding recommendation, higher proportions were white, more educated, married, of normal BMI, and nonsmokers. They also tended to have higher poverty income ratio and parity. Six years after delivery, women retained an average of 2.5 kg (SD = 10.5) more than their prepregnancy weight. Overall, normal weight and overweight women retained an average of 3.9 kg (SD = 7.3) and 2.7 kg (SD = 10.6), respectively, whereas obese women lost an average of 0.4 kg (SD = 14.1) (data not shown). Mean weight retention decreased as breastfeeding adherence increased only among obese women (Table 2).

## Breastfeeding Adherence and Weight Retention

Prepregnancy BMI modified the association between adherence to breastfeeding recommendations and weight retention ( $P = .02$ ); thus, results are presented stratified by prepregnancy BMI (Table 3). With adjustment for covariates and in comparison with those who never breastfed, adherence to breastfeeding recommendations was not significantly associated with weight retention among normal weight and overweight women. However, there was a significant linear trend ( $P = .01$ ) among mothers who were obese before pregnancy, suggesting that those who fully adhered to the breastfeeding recommendations retained less weight ( $-8.0$  kg, 95% confidence interval,  $-15.4$  to  $-0.7$ ) than women who never breastfed. Associations were similar in the sensitivity analysis (data not shown).

## DISCUSSION

This study used longitudinal data to explore the relationship between adherence to breastfeeding recommendations and maternal weight retention 6 years after delivery. Although we observed no associations between breastfeeding recommendation adherence and weight retention among normal and overweight mothers, our data suggest an inverse association among obese mothers. Specifically, we found that 6 years after delivery, obese women who fully adhered to the 2005 AAP recommendations for both breastfeeding exclusivity and duration retained 8.0 kg less than obese mothers who never breastfed.

Our findings may have public health implications. All women are advised to gain some weight during pregnancy; however, excess gestational weight gain can lead to postpartum weight retention.<sup>35</sup> Currently, 1 in 5 women who delivers a live birth is obese before pregnancy,<sup>36</sup> and nearly half of obese women gain gestational weight in excess of recommendations.<sup>37</sup> Obese women are at elevated risk for many chronic diseases; postpartum weight retention can exacerbate these risks.<sup>38</sup> Our study suggests that adherence to breastfeeding recommendations may have long-term effects that promote lower weight retention among obese women.

A recent systematic review concluded that there is currently insufficient evidence to support an association between breastfeeding and weight retention because of the considerable heterogeneity across studies, including different breastfeeding definitions, timing and measurement of maternal weight, participant characteristics, sample sizes, study design, and ability to adjust for confounders.<sup>7</sup> The review identified 15 prospective studies that met their inclusion criteria and assessed associations of breastfeeding with weight retention 6 to 24 months postpartum. Five of the studies were considered to be of high methodological quality,<sup>39–43</sup> and of these, 4<sup>39–41,43</sup> found a significant inverse association between breastfeeding and weight retention.

Two recent studies that were not part of the systematic review examined breastfeeding and maternal weight >2 years postpartum. Brandhagen and colleagues<sup>44</sup> conducted a longitudinal study among Norwegian women at various points for 3 years postpartum. They found an inverse association between breastfeeding (measured as full, partial, or none) and weight retention after controlling for prepregnancy BMI, pregnancy weight gain, maternal age, and parity. In the final assessment at 36 months postpartum, however, only mothers

who fully breastfed (gave breast milk but no infant formula, other milk, or semisolid or solid food) up to 6 months showed significantly lower weight retention.

Wiklund and colleagues<sup>45</sup> conducted a small retrospective study among Finnish mothers 16 to 20 years after their last pregnancy. Using self-reported data and maternity tracking records, they assessed mother's prepregnancy weight and average duration of breastfeeding across all their infants. Mothers were categorized as having a short duration of breastfeeding (defined as breastfeeding <6 months), a medium duration of breastfeeding (>6 months but <10 months), or a long duration of breastfeeding (>10 months). Mother's current weight and height were measured using standardized protocols. Analyses were adjusted for age at first pregnancy, parity, smoking, menopause status, education, previous and current physical activity levels, and current energy intake. After their first pregnancy, only mothers with long breastfeeding duration returned to their prepregnancy weight, whereas mothers with medium and short breastfeeding durations were 1.8 and 5.0 kg heavier, respectively ( $P < .001$ ). Although gradual weight gain was observed over time, this pattern of less weight retention with increased breastfeeding was also observed with subsequent pregnancies, such that nearly 2 decades after having their children, mothers with short duration of breastfeeding were found to have gained significantly more body weight (14.0 kg) than mothers in either the medium (8.3 kg,  $P < .001$ ) or long (7.6 kg,  $P < .001$ ) breastfeeding duration groups.

The current study is subject to some limitations. Weight and height measures were based on self-report, which could have led to misclassifications of BMI or errors in weight retention because women of higher BMI tend to underreport their weight.<sup>46,47</sup> The extent to which this bias might affect the reporting of weight at different times is unknown. In addition, we did not have data to adjust for dietary behaviors, and therefore we may have incomplete control of confounding. Our decision to limit analyses to mothers with no additional pregnancies after IFPSII reduced the size of our sample and may have limited our ability to detect significant associations; similarly, we had a limited number of mothers who met only the recommendation to breastfeed exclusively for >4 months. The IFPSII sample was not nationally representative, so the results may not be generalizable to all women.

Despite these limitations, our study has a number of strengths. Infant feeding practices in the first year postpartum were assessed nearly monthly in IFPSII, which reduced the potential for maternal recall bias regarding infant feeding practices. A particular strength of our study is that, because of the extensive details on infant feeding practices in the IFPSII data, we were able to measure and report breastfeeding exclusivity, intensity, and duration through the first year postpartum. Moreover, the highly detailed breastfeeding data enabled us to classify adherence to AAP breastfeeding recommendations into 4 levels that accounted for differing degrees of breastfeeding exclusivity, duration, and intensity throughout the first year postpartum, all of which could relate to lactation-related energy expenditure. Finally, to our knowledge, this is the first study to examine the influence of breastfeeding on weight retention 6 years after delivery.

The proportion of women in the United States breastfeeding exclusively and for long durations remains low.<sup>48</sup> In addition, disparities in breastfeeding practices among US mothers are evident, with lower initiation, duration, and exclusivity rates among those who

are young, are non-Hispanic black, and have low education and low incomes.<sup>49</sup> Rates of breastfeeding are also low among mothers who are obese.<sup>50–52</sup> Mothers who are obese experience higher rates of prolonged labor, which can lead to higher rates of cesarean birth, which can then lead to delayed lactogenesis.<sup>52</sup> In addition, obese women may experience more challenges with successful latch during breastfeeding than other women, thus interfering with a smooth start to breastfeeding and jeopardizing exclusive and continued breastfeeding.<sup>52</sup> Although these challenges often can be overcome with assistance from trained health care providers, a survey of clinicians revealed that <30% of them believed obesity could have detrimental effects on breastfeeding,<sup>53</sup> suggesting that additional education may be needed for health providers to help obese women achieve their personal breastfeeding goals.

Lactation requires energy expenditure; thus, a biological rationale supports the hypothesis that breastfeeding might promote postpartum weight loss.<sup>24,28,44</sup> However, multiple factors, such as women's BMI, physical activity, and diet, and organizational factors such as hospital maternity practices and worksite lactation support programs, influence breastfeeding and thus postpartum weight retention.<sup>7</sup> Among populations who experience high rates of obesity and low rates of breastfeeding, interventions that address lifestyle behaviors related to healthy weight and breastfeeding may be an effective way to reduce postpartum weight retention.

## CONCLUSION

This longitudinal study suggests an inverse association between adherence to breastfeeding recommendations on exclusivity and duration and long-term weight retention among obese women. Larger studies among diverse populations are needed to elucidate the association between breastfeeding and long-term weight retention.

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## ABBREVIATIONS

<b>AAP</b>	American Academy of Pediatrics
<b>IFPS II</b>	Infant Feeding Practices Study II
<b>Y6FU</b>	Year 6 Follow-Up

## References

1. Crane JM, Murphy P, Burrage L, Hutchens D. Maternal and perinatal outcomes of extreme obesity in pregnancy. *J Obstet Gynaecol Can.* 2013; 35(7):606–611. [PubMed: 23876637]
2. Cnattingius S, Villamor E, Johansson S, et al. Maternal obesity and risk of preterm delivery. *JAMA.* 2013; 309(22):2362–2370. doi:10.1001/jama.2013.6295 [PubMed: 23757084]

3. Flegal KM, Kit BK, Orpana H, Graubard BI. Association of all-cause mortality with overweight and obesity using standard body mass index categories: a systematic review and meta-analysis. *JAMA*. 2013; 309(1):71–82.10.1001/jama.2013.113905 [PubMed: 23280227]
4. Esposito K, Pontillo A, Di Palo C, et al. Effect of weight loss and lifestyle changes on vascular inflammatory markers in obese women: a randomized trial. *JAMA*. 2003; 289(14):1799–1804.10.1001/jama.289.14.1799 [PubMed: 12684358]
5. Morimoto LM, White E, Chen Z, et al. Obesity, body size, and risk of postmenopausal breast cancer: the Women’s Health Initiative (United States). *Cancer Causes Control*. 2002; 13(8):741–751. [PubMed: 12420953]
6. Flegal KM, Carroll MD, Ogden CL, Curtin LR. Prevalence and trends in obesity among US adults, 1999–2008. *JAMA*. 2010; 303(3):235–241.10.1001/jama.2009.2014 [PubMed: 20071471]
7. Neville CE, McKinley MC, Holmes VA, Spence D, Woodside JV. The relationship between breastfeeding and postpartum weight change: a systematic review and critical evaluation. *Int J Obes (Lond)*. 2014; 38(4):577–590.10.1038/ijo.2013.132 [PubMed: 23892523]
8. Wiltheiss GA, Lovelady CA, West DG, Brouwer RJ, Krause KM, Østbye T. Diet quality and weight change among overweight and obese postpartum women enrolled in a behavioral intervention program. *J Acad Nutr Diet*. 2013; 113(1):54–62. [PubMed: 23146549]
9. World Health Organization. Fifty-Fourth World Health Assembly. Global Strategy for Infant and Young Child Feeding. The Optimal Duration of Exclusive Breastfeeding. Geneva, Switzerland: World Health Organization; 2001.
10. Li R, Fein SB, Grummer-Strawn LM. Association of breastfeeding intensity and bottle-emptying behaviors at early infancy with infants’ risk for excess weight at late infancy. *Pediatrics*. 2008; 122(suppl 2):S77–S84. [PubMed: 18829835]
11. Ip, S.; Chung, M.; Raman, G., et al. Evidence Report/Technology Assessment No. 153. AHRQ Publication No. 07-E007. Rockville, MD: Agency for Healthcare Research and Quality; 2007. Breastfeeding and maternal and infant outcomes in developed countries.
12. Nishimura T, Suzue J, Kaji H. Breastfeeding reduces the severity of respiratory syncytial virus infection among young infants: a multi-center prospective study. *Pediatr Int*. 2009; 51(6):812–816. [PubMed: 19419530]
13. Duijts L, Jaddoe VW, Hofman A, Moll HA. Prolonged and exclusive breastfeeding reduces the risk of infectious diseases in infancy. *Pediatrics*. 2010; 126(1) Available at: [www.pediatrics.org/cgi/content/full/126/1/e18](http://www.pediatrics.org/cgi/content/full/126/1/e18).
14. Quigley MA, Kelly YJ, Sacker A. Breastfeeding and hospitalization for diarrheal and respiratory infection in the United Kingdom Millennium Cohort Study. *Pediatrics*. 2007; 119(4) Available at: [www.pediatrics.org/cgi/content/full/119/4/e837](http://www.pediatrics.org/cgi/content/full/119/4/e837).
15. Hauck FR, Thompson JM, Tanabe KO, Moon RY, Vennemann MM. Breastfeeding and reduced risk of sudden infant death syndrome: a meta-analysis. *Pediatrics*. 2011; 128(1):103–110. [PubMed: 21669892]
16. Parikh NI, Hwang SJ, Ingelsson E, et al. Breastfeeding in infancy and adult cardiovascular disease risk factors. *Am J Med*. 2009; 122(7):656–663. e1. [PubMed: 19559168]
17. Owen CG, Martin RM, Whincup PH, Smith GD, Cook DG. Does breastfeeding influence risk of type 2 diabetes in later life? A quantitative analysis of published evidence. *Am J Clin Nutr*. 2006; 84(5):1043–1054. [PubMed: 17093156]
18. Owen CG, Martin RM, Whincup PH, Davey-Smith G, Gillman MW, Cook DG. The effect of breastfeeding on mean body mass index throughout life: a quantitative review of published and unpublished observational evidence. *Am J Clin Nutr*. 2005; 82(6):1298–1307. [PubMed: 16332664]
19. Metzger MW, McDade TW. Breastfeeding as obesity prevention in the United States: a sibling difference model. *Am J Hum Biol*. 2010; 22(3):291–296. [PubMed: 19693959]
20. Wojcicki JM, Gugig R, Tran C, Kathiravan S, Holbrook K, Heyman MB. Early exclusive breastfeeding and maternal attitudes towards infant feeding in a population of new mothers in San Francisco, California. *Breastfeed Med*. 2010; 5(1):9–15. [PubMed: 19772374]
21. Stuebe AM, Rich-Edwards JW, Willett WC, Manson JE, Michels KB. Duration of lactation and incidence of type 2 diabetes. *JAMA*. 2005; 294(20):2601–2610. [PubMed: 16304074]

22. Schwarz EB, Brown JS, Creasman JM, et al. Lactation and maternal risk of type 2 diabetes: a population-based study. *Am J Med.* 2010; 123(9):863e1–e6. [PubMed: 20800156]
23. Schwarz EB, Ray RM, Stuebe AM, et al. Duration of lactation and risk factors for maternal cardiovascular disease. *Obstet Gynecol.* 2009; 113(5):974–982. [PubMed: 19384111]
24. Stuebe AM, Willett WC, Xue F, Michels KB. Lactation and incidence of premenopausal breast cancer: a longitudinal study. *Arch Intern Med.* 2009; 169(15):1364–1371. [PubMed: 19667298]
25. Collaborative Group on Hormonal Factors in Breast Cancer. Breast cancer and breastfeeding: collaborative reanalysis of individual data from 47 epidemiological studies in 30 countries, including 50302 women with breast cancer and 96973 women without the disease. *Lancet.* 2002; 360(9328):187–195. [PubMed: 12133652]
26. Danforth KN, Tworoger SS, Hecht JL, Rosner BA, Colditz GA, Hankinson SE. Breastfeeding and risk of ovarian cancer in two prospective cohorts. *Cancer Causes Control.* 2007; 18(5):517–523. [PubMed: 17450440]
27. Titus-Ernstoff L, Rees JR, Terry KL, Cramer DW. Breastfeeding the last born child and risk of ovarian cancer. *Cancer Causes Control.* 2010; 21(2):201–207. [PubMed: 19902367]
28. Lovelady C. Balancing exercise and food intake with lactation to promote postpartum weight loss. *Proc Nutr Soc.* 2011; 70(2):181–184. [PubMed: 21349230]
29. Stuebe AM, Rich-Edwards JW. The reset hypothesis: lactation and maternal metabolism. *Am J Perinatol.* 2009; 26(1):81–88. [PubMed: 19031350]
30. Gartner LM, Morton J, Lawrence RA, et al. American Academy of Pediatrics. Section on Breastfeeding. Breastfeeding and the use of human milk. *Pediatrics.* 2005; 115(2):496–506. [PubMed: 15687461]
31. Fein SB, Labiner-Wolfe J, Shealy KR, Li R, Chen J, Grummer-Strawn LM. Infant Feeding Practices Study II: study methods. *Pediatrics.* 2008; 122(Suppl 2):S28–S35.10.1542/peds.2008-1315c [PubMed: 18829828]
32. Fein SB, Li R, Chen J, Scanlon KS, Grummer-Strawn LM. Methods for the year 6 follow-up study of children in the Infant Feeding Practices Study II. *Pediatrics.* 2014; 134(suppl 1):S4–S12. [PubMed: 25183754]
33. Section on Breastfeeding. Breastfeeding and the use of human milk. *Pediatrics.* 2012; 129(3) Available at: [www.pediatrics.org/cgi/content/full/129/3/e827](http://www.pediatrics.org/cgi/content/full/129/3/e827). 10.1542/peds.2011-3552
34. Physical Activity Guidelines Advisory Committee. Physical Activity Guidelines Advisory Committee Report, 2008. Washington, DC: US Department of Health and Human Services; 2008. Available at: [www.health.gov/paguidelines](http://www.health.gov/paguidelines)
35. IOM (Institute of Medicine) and NRC (National Research Council). Weight Gain During Pregnancy: Reexamining the Guidelines. Washington, DC: The National Academies Press; 2009.
36. Fisher SC, Kim SY, Sharma AJ, Rochat R, Morrow B. Is obesity still increasing among pregnant women? Prepregnancy obesity trends in 20 states, 2003–2009. *Prev Med.* 2013; 56(6):372–378. [PubMed: 23454595]
37. IOM (Institute of Medicine) and NRC (National Research Council). Leveraging Action to Support Dissemination of Pregnancy Weight Gain Guidelines. Washington, DC: The National Academies Press; 2013.
38. Amorim Adegboye AR, Linne YM. Diet or exercise, or both, for weight reduction in women after childbirth. *Cochrane Database Syst Rev.* 2013; 7:CD005627.10.1002/14651858.CD005627.pub3 [PubMed: 23881656]
39. Martin JE, Hure AJ, Macdonald-Wicks L, Smith R, Collins CE. Predictors of postpartum weight retention in a prospective longitudinal study. *Matern Child Nutr.* published online ahead of print September 13, 2012. 10.1111/j.1740-8709.2012.00437.x
40. Öhlin A, Rössner S. Maternal body weight development after pregnancy. *Int J Obes Disord.* 1990; 14(2):159–173.
41. Olson CM, Strawderman MS, Hinton PS, Pearson TA. Gestational weight gain and postpartum behaviors associated with weight change from early pregnancy to 1 y postpartum. *Int J Obes Relat Metab Disord.* 2003; 27(1):117–127. [PubMed: 12532163]

42. Østbye T, Peterson BL, Krause KM, Swamy GK, Lovelady CA. Predictors of postpartum weight change among overweight and obese women: results from the Active Mothers Postpartum study. *J Womens Health (Larchmt)*. 2012; 21(2):215–222. [PubMed: 22092110]
43. Dewey KG, Heinig MJ, Nommsen LA. Maternal weight-loss patterns during prolonged lactation. *Am J Clin Nutr*. 1993; 58(2):162–166. [PubMed: 8338042]
44. Brandhagen M, Lissner L, Brantsaeter AL, et al. Breastfeeding in relation to weight retention up to 36 months postpartum in the Norwegian Mother and Child Cohort Study: modification by socio-economic status? *Public Health Nutr*. 2014; 17(7):1514–1523. [PubMed: 23915637]
45. Wiklund P, Xu L, Lyytikäinen A, et al. Prolonged breastfeeding protects mothers from later-life obesity and related cardio-metabolic disorders. *Public Health Nutr*. 2012; 15(1):67–74. [PubMed: 21859508]
46. Connor Gorber S, Tremblay M, Moher D, Gorber B. A comparison of direct vs. self-report measures for assessing height, weight and body mass index: a systematic review. *Obes Rev*. 2007; 8(4):307–326. [PubMed: 17578381]
47. Shapiro JR, Anderson DA. The effects of restraint, gender, and body mass index on the accuracy of self-reported weight. *Int J Eat Disord*. 2003; 34(1):177–180. [PubMed: 12772184]
48. Centers for Disease Control and Prevention. [Accessed August 8, 2013] Breastfeeding report card. 2013. Available at: [www.cdc.gov/breastfeeding/data/reportcard.htm](http://www.cdc.gov/breastfeeding/data/reportcard.htm)
49. Centers for Disease Control and Prevention. Breastfeeding among US children born in 2007. CDC National Immunization Survey. Available at: [www.cdc.gov/breastfeeding/data/NIS\\_data/2007/socio-demographic\\_any.htm](http://www.cdc.gov/breastfeeding/data/NIS_data/2007/socio-demographic_any.htm)
50. Krause KM, Lovelady CA, Østbye T. Predictors of breastfeeding in overweight and obese women: data from Active Mothers Postpartum (AMP). *Matern Child Health J*. 2011; 15(3):367–375. [PubMed: 20821042]
51. Li R, Jewell S, Grummer-Strawn L. Maternal obesity and breast-feeding practices. *Am J Clin Nutr*. 2003; 77(4):931–936. [PubMed: 12663294]
52. Jevitt C, Hernandez I, Groër M. Lactation complicated by overweight and obesity: supporting the mother and newborn. *J Midwifery Womens Health*. 2007; 52(6):606–613. [PubMed: 17983998]
53. Rasmussen KM, Lee VE, Ledkovsky TB, Kjolhede CL. A description of lactation counseling practices that are used with obese mothers. *J Hum Lact*. 2006; 22(3):322–327. [PubMed: 16885492]

TABLE 1

Characteristics of 726 Women Included in the Study, Stratified by Adherence to Breastfeeding Recommendations<sup>a,b</sup>

	Never Initiated Breastfeeding (n = 130)	Initiated Breastfeeding, Did Not Exclusively Breastfeed for 4 mo (n = 423)	Adhered to Exclusivity for 4 mo, Breastfeeding Duration <12 mo (n = 52)	Adhered to Both Exclusivity for 4 mo and Breastfeeding 12 mo (n = 121)	P
Median [interquartile range] breastfeeding duration (mo)	0	6.5 [1.2–10.2]	8.6 [6.8–10.0]	18.9 [12.5–18.1]	<.0001
Maternal age (y)	31.5 (4.8)	31.5 (5.6)	31.6 (4.4)	32.5 (4.5)	.28
Race or ethnicity					.002
White	19.4	55.5	7.5	17.7	
Nonwhite	9.1	75.8	5.1	10.1	
Education					<.0001
High school or less	26.6	61.5	3.7	8.3	
Some college	19.5	62.4	6.4	11.7	
College and beyond	13.7	53.7	9.0	23.6	
Poverty income ratio					.05
185%	23.8	54.8	6.8	14.7	
186%–300%	14.8	56.7	7.6	21.0	
>300%	14.8	62.9	7.2	15.2	
Marital status					.002
Married	17.8	56.0	8.3	17.9	
Not married	18.6	70.8	0.9	9.7	
Parity					.05
0	14.7	69.8	3.9	11.6	
1	20.3	56.2	7.5	16.1	
2+	16.1	55.2	8.5	20.2	
Prepregnancy BMI					.02
Normal	15.8	55.4	8.9	19.9	
Overweight	16.2	60.8	5.9	17.2	
Obese	23.7	60.8	5.4	10.2	
Gestational wt gain (kg)	13.4 (6.7)	13.6 (6.7)	15.4 (5.2)	14.0 (5.4)	.20
Current smoking status					<.0001
Smoker	26.3	68.4	3.2	2.1	

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	Never Initiated Breastfeeding ( <i>n</i> = 130)	Initiated Breastfeeding, Did Not Exclusively Breastfeed for 4 mo ( <i>n</i> = 423)	Adhered to Exclusivity for 4 mo, Breastfeeding Duration <12 mo ( <i>n</i> = 52)	Adhered to Both Exclusivity for 4 mo and Breastfeeding 12 mo ( <i>n</i> = 121)	<i>P</i>
Nonsmoker	16.6	56.7	7.8	18.9	
Physical activity					.58
Sedentary	23.5	61.8	2.9	11.8	
Some physical activity	21.3	52.5	11.5	14.8	
Meets physical activity recommendations	17.3	58.6	7.0	17.1	

<sup>a</sup>Breastfeeding recommendations are drawn from the 2005 American Academy of Pediatrics Statement on Breastfeeding and the Use of Human Milk.<sup>30</sup>

<sup>b</sup>Values provided as mean (SD) or % unless specified otherwise.

Mean Wt Retention (kg) Stratified by Adherence to Breastfeeding Recommendations and Prepregnancy BMI<sup>a,b</sup>

TABLE 2

	Never Initiated Breastfeeding		Initiated Breastfeeding, Did Not Exclusively Breastfeed for 4 mo		Adhered to Exclusivity for 4 mo, Breastfeeding Duration <12 mo		Adhered to Both Exclusivity for 4 mo and Breastfeeding 12 mo		P
	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	
All women	130	2.1 (10.0)	423	3.0 (10.8)	52	0.9 (9.6)	121	1.6 (9.9)	.33
Normal wt	53	4.4 (6.8)	186	4.2 (8.3)	30	2.9 (4.6)	67	2.9 (5.7)	.47
Overweight	33	1.2 (8.5)	124	2.9 (10.6)	12	-0.3 (9.3)	35	4.7 (12.4)	.39
Obese	44	-0.9 (13.3)	113	1.2 (14.2)	10	-3.8 (17.5)	19	-8.6 (10.4)	.03

<sup>a</sup>Breastfeeding recommendations are drawn from the 2005 American Academy of Pediatrics Statement on Breastfeeding and the Use of Human Milk.<sup>30</sup>

<sup>b</sup>Wt retention defined as difference between self-reported wt 6 y after delivery and self-reported wt before pregnancy reported during the third trimester.

Wt Retention (kg) From Prepregnancy to 6 Years After Delivery by Adherence to Breastfeeding Recommendations, Stratified by Prepregnancy BMI<sup>a</sup>

TABLE 3

	Prepregnancy BMI					
	Normal Wt (n = 336)		Overweight (n = 204)		Obese (n = 186)	
	$\beta$ (95% CI)	P	$\beta$ (95% CI)	P	$\beta$ (95% CI)	P
Adherence to breastfeeding recommendations		.43 <sup>b</sup>		.58 <sup>b</sup>		.01 <sup>b</sup>
Never breastfed	Ref		Ref		Ref	
Initiated breastfeeding but did not exclusively breastfeed for 4 mo	-0.3 (-2.5 to 1.9)	.80	2.0 (-1.9 to 5.8)	.32	0.9 (-3.8 to 5.7)	.70
Exclusively breastfed for 4 mo, breastfeeding duration <12 mo	-0.8 (-4.0 to 2.4)	.61	-2.5 (-9.4 to 4.5)	.49	-5.3 (-14.7 to 4.1)	.27
Exclusively breastfed for 4 mo, breastfeeding duration 12 mo	-0.9 (-3.5 to 1.7)	.49	3.0 (-1.9 to 7.9)	.23	-8.0 (-15.4 to -0.7)	.03

CI, confidence interval.

<sup>a</sup>Models adjusted for maternal age, race or ethnicity, education, poverty income ratio, marital status, parity, and gestational wt gain from baseline as well as current smoking status and physical activity from follow-up study.

<sup>b</sup>Test for linear trend.