

Breastfeeding reduces postpartum weight retention¹⁻⁴

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ABSTRACT

Background: Weight gained during pregnancy and not lost postpartum may contribute to obesity in women of childbearing age.

Objective: We aimed to determine whether breastfeeding reduces postpartum weight retention (PPWR) in a population among which full breastfeeding is common and breastfeeding duration is long.

Design: We selected women from the Danish National Birth Cohort who ever breastfed (>98%), and we conducted the interviews at 6 ($n = 36\ 030$) and 18 ($n = 26\ 846$) mo postpartum. We used regression analyses to investigate whether breastfeeding (scored to account for duration and intensity) reduced PPWR at 6 and 18 mo after adjustment for maternal prepregnancy body mass index (BMI) and gestational weight gain (GWG).

Results: GWG was positively ($P < 0.0001$) associated with PPWR at both 6 and 18 mo postpartum. Breastfeeding was negatively associated with PPWR in all women but those in the heaviest category of prepregnancy BMI at 6 ($P < 0.0001$) and 18 ($P < 0.05$) mo postpartum. When modeled together with adjustment for possible confounding, these associations were marginally attenuated. We calculated that, if women exclusively breastfed for 6 mo as recommended, PPWR could be eliminated by that time in women with GWG values of ≈ 12 kg, and that the possibility of major weight gain (≥ 5 kg) could be reduced in all but the heaviest women.

Conclusion: Breastfeeding was associated with lower PPWR in all categories of prepregnancy BMI. These results suggest that, when combined with GWG values of ≈ 12 kg, breastfeeding as recommended could eliminate weight retention by 6 mo postpartum in many women. *Am J Clin Nutr* 2008;88:1543–51.

INTRODUCTION

In the latest national data, US women of reproductive age are alarmingly heavy: 52% are overweight, 29% are obese, and 8% have a body mass index (BMI; in kg/m^2) of ≥ 40 , which places them in the obese III category (1). Those who are obese have difficulty conceiving (2), and complications during pregnancy and delivery are more common in obese than in normal-weight women (3–5). In addition, reproduction itself is associated with a net gain in weight. On average, weight retention postpartum is thought to be modest—1.3 kg at 10–18 mo after delivery in 1.59 million women in the 1988 National Maternal and Infant Health Survey (6)—but it is more generally estimated as ≈ 0.5 kg in US (7–9), Swedish (10), and British women (11). For individual women, however, pregnancy may be quite an important cause of weight gain (12). For example, Olson et al (13) found that 25% of the 540 women in their study experienced a major weight gain (≥ 4.55 kg) associated with pregnancy. Weight retention may be

higher after first births than after higher-order births (14–16). Gestational weight gain (GWG) may contribute to complications during labor and delivery (4, 17), and it is an important determinant of postpartum weight retention (PPWR). In general, the more weight that women gain during pregnancy, the more weight that they retain afterward (18). Interventions to restrain GWG in the United States and elsewhere have not been uniformly successful in reducing PPWR (19–22). In fact, the proportion of US women who gain weight excessively during pregnancy is growing (23). In 2005, 20.6% gained > 18.2 kg (40 lb) (24), the upper limit recommended by the Institute of Medicine (25) for women of any height.

Evidence is limited and conflicting about whether women who breastfeed their infants lose more weight than do women who do not breastfeed (25–27). Most of the women in those studies did not follow the current recommendations to exclusively breastfeed for 6 mo and then to continue breastfeeding for ≥ 6 more mo (28). Moreover, there is a reproducible, negative association between prepregnancy BMI and the duration of breastfeeding (29), and evidence is accumulating that obesity makes breastfeeding more difficult (30). Thus, it is possible that the lack of a consistent relation between breastfeeding and a reduction in PPWR has resulted from a combination of a pattern of breastfeeding that would not be expected to modify weight loss appreciably, low statistical power, or the poor quality of information

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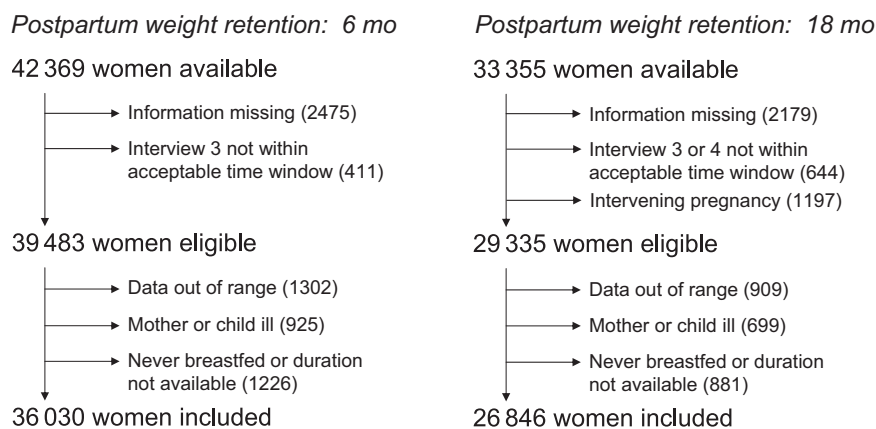


FIGURE 1. Diagram of Danish National Birth Cohort subjects included in the analyses at 6 and 18 mo postpartum. Women who had completed a subsequent pregnancy or who did not know if they were currently pregnant at 18 mo postpartum are included in “intervening pregnancy.”

about the intensity and duration of breastfeeding (or all 3 factors), as well as a complex association with prepregnancy BMI.

The prospectively collected data from the Danish National Birth Cohort (DNBC) provided a resource in which the association of breastfeeding and PPWR could be examined in a context of intense and sustained breastfeeding. We studied women from this large contemporary cohort and evaluated whether breastfeeding, which was reported in detail, modified the association among prepregnancy BMI, GWG, and PPWR at 6 and 18 mo postpartum.

SUBJECTS AND METHODS

Subjects

The study population was derived from women who participated in the DNBC, a prospective study of women and infants (31) that was established in 1996. Women were invited to participate in the DNBC by their general practitioner at the first prenatal visit at 6–12 wk of pregnancy. To be eligible for the cohort, they had to plan to continue with the pregnancy, live in Denmark, and speak Danish well enough to participate in telephone interviews (31). After enrollment in the DNBC, women were interviewed by telephone 4 times—at ≈12 and 26 wk of gestation and at 6 and 18 mo postpartum. Information about medical conditions that the woman experienced during pregnancy and the delivery and characteristics of her infant at birth was obtained via linkage between the subject’s Civil Person’s Registry number and the Danish National Hospital Discharge Register.

To be considered available for either portion of this investigation, subjects were required to have delivered a liveborn, singleton infant; to have completed at least interviews 1–3, and to have full data available from the linked registers. Furthermore, the subjects had to respond to the version of the questionnaires that permitted the determination of the duration of full breastfeeding (29). This meant that we included only women who completed interview 1 on or after March 1999. The last interview for this sample was completed in October 2004. A total of 5209 women participated more than once in the DNBC and completed interviews 1–3 or 1–4. In such cases, we systematically chose the pregnancy with 4 interviews if one was available. If only 3

interviews were available, we systematically chose the second pregnancy within the DNBC.

By these criteria, 42 369 women were available for an investigation of PPWR at 6 mo postpartum (Figure 1, left). After exclusions for missing information, failure to complete interview 3 within an acceptable timeframe, out-of-range data (maternal age < 18 or > 45 y, gestational age < 259 d, or birth weight < 2000 g), and incomplete breastfeeding information, 36 030 women were included in the investigation of PPWR at 6 mo postpartum. To investigate PPWR at 18 mo postpartum, potential subjects were also required to have completed interview 4. By this criterion and the criteria listed above, 33 355 women were available for this portion of the study (Figure 1, right). After exclusions similar to those of the investigation at 6 mo postpartum, 26 846 women were included in the investigation of PPWR at 18 mo postpartum.

All of the subjects gave written informed consent. The study was approved by the Danish Data Protection Agency.

Variable descriptions

Information on each woman’s self-reported prepregnancy weight and height was obtained from the interview at 12 wk of gestation. BMI was calculated by using these values and classified into 5 categories according to the criteria of the World Health Organization; the BMIs of women in obese class II and above were combined as a BMI of ≥ 35.0 (32). GWG was obtained by self-report at the interview 6 mo postpartum, and its use has been validated (33). It was used as a continuous variable.

In the interview at 6 mo postpartum, women were asked about how they had been and currently were feeding their babies, including the duration of breastfeeding, use of infant formula or cow’s milk, and the introduction of complementary food. At 18 mo postpartum, women were asked if they were still breastfeeding their infant and, if not, when breastfeeding ended. Inasmuch as we could not with certainty distinguish “exclusive” breastfeeding (no other liquids and no solid foods given to the infant) from “almost exclusive” breastfeeding (vitamins, minerals, or water given infrequently), we have used the term “full breastfeeding,” which includes both of these practices, for our outcome (34). Further details on the creation of the breastfeeding variables are available elsewhere (29).

TABLE 1

Baseline characteristics of mother-infant dyads by prepregnancy BMI values of those who were included in the 6-mo analyses¹

Characteristic	Maternal prepregnancy BMI category				
	Underweight (n = 1516)	Normal-weight (n = 24 590)	Overweight (n = 7076)	Obese I (n = 2119)	Obese II and III (n = 729)
Maternal age (y)	29.8 ± 4.3 ^{2,3}	30.7 ± 4.2	30.4 ± 4.2 ³	30.1 ± 4.4 ³	29.9 ± 4.0 ³
Height (y)	1.7 ± 0.1	1.7 ± 0.1	1.7 ± 0.1 ⁴	1.7 ± 0.1 ³	1.7 ± 0.1 ³
Prepregnancy weight (kg)	50.8 ± 3.9 ³	62.2 ± 6.4	76.8 ± 6.8 ³	90.3 ± 7.6 ³	108.5 ± 12.2 ³
Prepregnancy BMI (kg/m ²)	17.8 ± 0.7 ³	21.8 ± 1.7	27.0 ± 1.4 ³	31.9 ± 1.4 ³	38.5 ± 3.3 ³
Primiparous [n (%)] ⁵	621 (46.1) [1515]	11 795 (48.0) [24 573]	3086 (43.8) [7068]	940 (44.4) [2118]	300 (41.2)
Maternal education and occupation (%)					
Highest educational level	15.0	17.8	12.9	9.2	7.3
Medium educational level	21.8	28.6	26.2	22.6	20.9
Skilled worker	40.9	34.1	41.6	46.3	49.3
Unskilled worker or unemployed	6.5	4.6	7.7	10.9	11.5
Student	15.1	14.2	11.1	10.6	10.3
Unknown	0.7	0.6	0.6	0.5	0.8
Smoked during breastfeeding period [n (%)] ⁵	23.0	3688 (15.0) [24 585]	1096 (15.5) [7073]	16.8	14.3
Self-reported gestational weight gain (kg)	15.4 ± 4.9 ⁶	15.7 ± 5.2	14.8 ± 6.4 ³	11.4 ± 7.4 ³	8.0 ± 9.2 ³
Percentiles of gestational weight gain (kg)					
20th Percentile	11	12	10	6	3
50th Percentile	15	15	14	11	8
80th Percentile	20	20	20	17	14
Gestation duration (d)	281 ± 10 ³	282 ± 9	283 ± 10 ³	283 ± 10	283 ± 10
Cesarean delivery [n (%)] ⁵	162 (10.8) [1499]	3169 (13.0) [24 378]	1200 (17.1) [7016]	425 (20.1) [2113]	180 (24.9) [724]
Birth weight (kg)	3.43 ± 0.46 ³	3.62 ± 0.48	3.72 ± 0.50 ³	3.74 ± 0.53 ⁴	3.80 ± 0.53 ³

¹ BMI values (measured in kg/m²) by category are: underweight, <18.5; normal-weight, 18.5–24.9; overweight, 25.0–29.9; obese I, 30.0–34.9; obese II and III, ≥35.0.

² $\bar{x} \pm SD$ (all such values).

^{3,4,6} Significantly different from normal-weight women (ANOVA, Dunnett's test): ³ $P < 0.0001$, ⁴ $P < 0.001$, ⁶ $P < 0.05$.

⁵ Numbers in brackets are the total number of women with data.

To capture both the intensity and duration of breastfeeding, we created a scale that reflects the energy cost of full and partial lactation (35). Women were assigned 1 point/wk of full breastfeeding and 0.5 point/wk for partial breastfeeding up until the infant was 1 y old. After that, women were assigned 0.25 point/wk for any continued breastfeeding, which reflected the reduced energy costs of lactation as a result of the addition of other foods to the infant's diet (35). The breastfeeding scale was used as a continuous variable.

Postpartum weight retention, the outcome for these analyses, was calculated as the difference between a woman's prepregnancy weight and her current reported weight at the interviews 6 mo and 18 mo postpartum, respectively. At 18 mo, women were asked if they had given birth or become pregnant since the last interview. Women who had given birth between the interviews at 6 and 18 mo or who did not know if they were currently pregnant were excluded from these analyses. If a woman was pregnant at the 18-mo interview, she was asked to report her prepregnancy weight, and that value was used in the analyses.

Baseline characteristics of the women, such as age, parity, and occupation, were obtained from the interview at 12 wk. Information about potentially confounding variables, such as smoking habits during the breastfeeding period, were obtained from the 6-mo postpartum interview. Infant sex was obtained from the Danish National Birth Register, as was the mode of delivery and the infant's birth weight and gestational age.

Statistical analysis

To examine whether characteristics of included and excluded women differed, those characteristics were compared with the use of Student's *t* test or chi-square test, as appropriate. To test whether characteristics of women differed by their prepregnancy BMI category, ANOVA was used. Normal-weight women were the reference group, and characteristics of all other women were compared with the characteristics of the normal-weight women by using Dunnett's test. In addition, trend tests were performed.

The outcome for these analyses was PPWR at 6 and 18 mo. A priori specified interactions among prepregnant BMI, GWG, and breastfeeding on weight retention at 6 and 18 mo were tested by using multiple linear regression. A significant interaction was identified only between categories of prepregnancy BMI and GWG ($P < 0.0001$), so all subsequent analyses were stratified by prepregnancy BMI. The effects of GWG and breastfeeding on weight retention at 6 mo postpartum were tested by using multiple linear regression. Interactions between breastfeeding and parity were tested within each prepregnancy BMI stratum. All analyses were adjusted for maternal age, parity, occupation, smoking during the breastfeeding period, and the timing of the 6-mo interview. Similar analyses were performed for weight retention at 18 mo postpartum.

To illustrate the joint effects of GWG and breastfeeding on weight retention at 6 and 18 mo postpartum, predictions were

TABLE 2

Maternal weight, breastfeeding behavior, and interview timing by prepregnancy BMI values and time postpartum¹

Characteristic	Maternal prepregnancy BMI category				
	Underweight	Normal-weight	Overweight	Obese I	Obese II and III
6 mo Postpartum					
Subjects (<i>n</i>)	1516	24 590	7076	2119	729
Still breastfeeding to any extent (%)	66.4	72.5	63.5	54.8	49.7
Breastfeeding scale points	18.2 ± 6.8 ^{2,3}	18.8 ± 6.3	17.4 ± 7.1 ⁴	15.7 ± 7.9 ⁴	14.9 ± 8.1 ⁴
Weight retention (kg)	2.4 ± 3.6 ⁴	1.7 ± 4.1	1.1 ± 5.7 ⁴	-1.2 ± 6.5 ⁴	-3.7 ± 8.2 ⁴
Timing of interview (wk postpartum)	27.1 ± 2.9	27.0 ± 2.7	27.0 ± 2.8	27.0 ± 2.7	27.0 ± 2.8
18 mo Postpartum					
Subjects (<i>n</i>)	1117	18 412	5250	1558	509
Was breastfeeding to any extent at 1 y (%)	18.1	15.4	13.1	11.6	11.2
Breastfeeding scale points	23.7 ± 11.3	24.0 ± 10.5	21.7 ± 11.2 ⁴	19.6 ± 11.8 ⁴	18.8 ± 12.1 ⁴
Weight retention (kg)	1.5 ± 3.0 ⁴	0.4 ± 3.7	-0.7 ± 5.8 ⁴	-2.9 ± 7.7 ⁴	-5.3 ± 9.6 ⁴
Timing of interview (wk postpartum)	84.1 ± 4.9	84.1 ± 4.9	84.0 ± 4.9	84.0 ± 4.9	84.0 ± 5.1

¹ Categories by BMI (measured in kg/m²) are: underweight, <18.5; normal-weight, 18.5–24.9; overweight, 25.0–29.9; obese I, 30–34.9; obese II and III, ≥35.0.

² $\bar{x} \pm SD$ (all such values).

^{3,4} Significantly different from normal-weight women (ANOVA, Dunnett's test): ³*P* < 0.001, ⁴*P* < 0.0001.

made by using the regression estimates. GWG values corresponding to the 20th, 50th, and 80th percentiles for each of the prepregnancy BMI strata were used (Table 1). Predictions were made for 4 groups of breastfeeding behaviors—1) very little (<1 wk of full and any breastfeeding), 2) 1 mo of full and 2 mo of any breastfeeding, 3) 3 mo of full and 3 mo of any breastfeeding (groups 2 and 3 reflect common patterns observed in US women in the National Immunization Survey) (36, 37), and 4) 6 mo of full followed by 6 mo of any breastfeeding (the pattern recommended by the American Academy of Pediatrics and the World Health Organization) (36, 38).

Moreover, the risk of retaining a significant amount of weight (≥5 kg), which corresponds to the 80–87th percentiles of weight retention at 6 mo and the 87–90th percentiles at 18 mo in the prepregnancy BMI groups, was investigated by logistic regression. The regressions included all relevant parameters, and a step-wise linear estimation of the effect of GWG (using the same percentile values as above) on weight retention was performed. From these models, the estimated probability of retaining ≥5 kg at 6 and 18 mo, respectively, was calculated. All data were analyzed by using SAS software (version 9.2; SAS Institute Inc, Cary, NC) on a personal computer.

RESULTS

The women who were included in the present study differed significantly from those who were excluded at 6 and 18 mo. Included women were 2.6 kg lighter and gained 1.3 kg more during pregnancy than did the excluded women, but in many cases, the differences were small and were assumed to be biologically unimportant (data not shown). In the women who were studied at 6 mo postpartum (except underweight women), GWG decreased with increasing prepregnancy BMI values (*P* for trend < 0.0001) (Table 1). We observed a similar trend at 18 mo postpartum (data not shown). Scores on the breastfeeding scale at 6 and 18 mo postpartum decreased with increasing BMI for all groups except underweight women, as did PPWR (*P* for trend < 0.0001) (Table 2).

GWG was positively and significantly associated with PPWR in every category of prepregnancy BMI (Table 3), with values of 0.30–0.40 kg retained per 1 kg gained. This relation was still present at 18 mo, but it was attenuated to 0.16–0.21 kg retained per 1 kg gained (Table 3).

Breastfeeding did not interact significantly with prepregnancy BMI for PPWR, and it was negatively and significantly associated with PPWR in subjects in all categories of prepregnancy BMI except obese II and III at both 6 and 18 mo postpartum (Table 3). We found an interaction between breastfeeding and parity for weight retention, but it was significant only in normal-weight women and only for the comparison of primiparity with multiparity. At 6 mo, primiparas lost more weight per breastfeeding point than did multiparas (0.10 and 0.05 kg, respectively). Similar results were found at 18 mo: primiparas lost 0.03 kg more per breastfeeding point, whereas multiparas lost 0.01 kg more/point. An investigation of this interaction in the other prepregnancy BMI categories generally showed an effect in the same direction, but the differences were much smaller and the CIs were wide. Therefore, results are presented for models without interactions. For every 1-point increase in breastfeeding, weight retention was reduced by 0.06–0.09 kg and 0.01–0.04 kg at 6 and 18 mo postpartum, respectively. In models that included both GWG and breastfeeding (Table 3) and that were adjusted for potential confounding, there was little attenuation of the relations between each of these factors and PPWR.

To illustrate the potential contribution of breastfeeding to the reduction of PPWR, we calculated the amount of weight that a typical woman in the DNBC (ie, primiparous, 30 y old, non-smoker, and skilled worker) would retain with various amounts of GWG and patterns of breastfeeding. From these analyses, we predict that women who breastfeed as recommended would retain ≈2 kg less at 6 mo than would women who do not breastfeed, regardless of how much weight they gained while pregnant (Figure 2, normal-weight and obese women). For normal-weight women who gained ≈12 kg, adhering to the recommended pattern of breastfeeding would eliminate weight retention by 6 mo



TABLE 3

Association of breastfeeding with weight retention at 6 and 18 mo postpartum¹

Outcome	Maternal prepregnancy BMI category									
	Underweight		Normal-weight		Overweight		Obese I		Obese II and III	
	Parameter estimate (SE)	P	Parameter estimate (SE)	P	Parameter estimate (SE)	P	Parameter estimate (SE)	P	Parameter estimate (SE)	P
6-mo Weight retention ²										
Model 1: BWG (kg)	0.30 (0.02)	<0.0001	0.34 (0.00)	<0.0001	0.40 (0.01)	<0.0001	0.39 (0.02)	<0.0001	0.40 (0.03)	<0.0001
Model 2: BF scale (per point)	-0.06 (0.01)	<0.0001	-0.09 (0.00)	<0.0001	-0.07 (0.01)	<0.0001	-0.08 (0.02)	<0.0001	-0.07 (0.04)	0.0653
Model 3										
GWG (kg)	0.29 (0.02)	<0.0001	0.34 (0.00)	<0.0001	0.40 (0.01)	<0.0001	0.39 (0.02)	<0.0001	0.41 (0.03)	<0.0001
BF scale (per point)	-0.05 (0.01)	<0.0001	-0.07 (0.00)	<0.0001	-0.07 (0.01)	<0.0001	-0.09 (0.02)	<0.0001	-0.08 (0.03)	0.0120
Model 4 ³										
GWG (kg)	0.30 (0.02)	<0.0001	0.34 (0.00)	<0.0001	0.40 (0.01)	<0.0001	0.39 (0.02)	<0.0001	0.40 (0.03)	<0.0001
BF scale (per point)	-0.06 (0.01)	<0.0001	-0.08 (0.00)	<0.0001	-0.08 (0.01)	<0.0001	-0.09 (0.02)	<0.0001	-0.06 (0.03)	0.1099
18-mo Weight retention ⁴										
Model 1: GWG (kg)	0.16 (0.02)	<0.0001	0.16 (0.01)	<0.0001	0.18 (0.01)	<0.0001	0.18 (0.03)	<0.0001	0.20 (0.05)	<0.0001
Model 2: BF scale (per point)	-0.02 (0.01)	0.0256	-0.02 (0.00)	<0.0001	-0.02 (0.01)	0.0296	-0.04 (0.02)	0.0096	-0.02 (0.04)	0.5187
Model 3:										
GWG (kg)	0.16 (0.02)	<0.0001	0.16 (0.01)	<0.0001	0.18 (0.01)	<0.0001	0.18 (0.03)	<0.0001	0.20 (0.05)	<0.0001
BF scale (per point)	-0.01 (0.01)	0.0565	-0.01 (0.00)	<0.0001	-0.01 (0.01)	0.0702	-0.04 (0.02)	0.0144	-0.01 (0.03)	0.6795
Model 4 ⁵										
GWG (kg)	0.16 (0.02)	<0.0001	0.16 (0.01)	<0.0001	0.17 (0.01)	<0.0001	0.18 (0.03)	<0.0001	0.21 (0.05)	<0.0001
BF scale (per point)	-0.01 (0.01)	0.0855	-0.02 (0.00)	<0.0001	-0.02 (0.01)	0.0380	-0.04 (0.02)	0.0308	0.003 (0.04)	0.9372

¹ BF, breastfeeding; GWG, gestational weight gain. Weight categories by BMI (measured in kg/m²) are: underweight, <18.5; normal-weight, 18.5–24.9; overweight, 25.0–29.9; obese I, 30.0–34.9; obese II and III, ≥35.0.

² Adjusted for the time postpartum of interview 3.

³ Adjusted for maternal age, parity, maternal occupation, cesarean delivery, and smoking during breastfeeding.

⁴ Adjusted for the time postpartum of interview 4.

⁵ Adjusted for maternal age, parity, maternal occupation, and smoking during breastfeeding.

postpartum. For those who gained more than 12 kg, the recommended pattern of breastfeeding would reduce but not eliminate PPWR by 6 mo. From these analyses, we also predict that normal-weight women who breastfeed as recommended would retain ≈0.5 kg less at 18 mo than would those who breastfeed for a short duration (<1 wk), regardless of the amount of weight they gained while pregnant (Figure 2). In obese women at 6 mo postpartum, we predict that those who gain 6 kg will experience a net weight loss. For those obese women who gain 11 kg, breastfeeding would eliminate PPWR, and for those who gain 17 kg, it would nearly eliminate PPWR by 6 mo postpartum. By 18 mo postpartum, all obese women would experience a net weight loss relative to their prepregnancy weight, but breastfeeding as recommended would result in a net loss ≈1.3 kg greater. Similar patterns were predicted for women in other weight categories (data not shown).

Because high PPWR is a concern for many women, we investigated how GWG and breastfeeding may affect the risk of retaining ≥5 kg of the GWG at 6 and 18 mo postpartum. The logistic regression models showed that, in normal-weight women, breastfeeding was protective against retaining ≥5 kg: the odds ratio (OR) was 0.68 (95% CI: 0.64, 0.71) per 10 breastfeeding points. Similar ORs were found for all other groups of women except women who were obese class II and above, in whom the OR was not significant (data not shown). With the use of these ORs, the probability of retaining ≥5 kg GWG was calculated for the typical DNBC woman (described above) in

each of the prepregnancy BMI groups. Of women at or below the median GWG for their prepregnancy BMI category (Table 1), the probability of retaining ≥5 kg GWG at 6 mo postpartum was nearly 50% less in those who breastfed as recommended than in those who breastfed for <1 wk (Figure 3, normal-weight and obese women only). In underweight, normal-weight, and overweight women, the probability of retaining ≥5 kg GWG at 6 mo postpartum was >50% for those who gained >20 kg during pregnancy and breastfed for <1 wk. In the women in the obese categories, the probability of retaining ≥5 kg GWG at 6 mo postpartum was lower. At 18 mo, the results were attenuated, but, here also, women who breastfed as recommended had the lowest probability of retaining ≥5 kg GWG, irrespective of the total GWG (data not shown).

DISCUSSION

The possibility that breastfeeding may assist women in minimizing weight retention after pregnancy has long been controversial. The data and analyses presented here address many of the methodologic problems that have contributed to this controversy. We showed that breastfeeding as recommended (ie, breastfeeding exclusively for 6 mo and to any extent for 12 mo) made an independent contribution to the reduction of PPWR at 6 mo postpartum, irrespective of prepregnancy BMI value, and at 18 mo postpartum in women with BMI values between 18.5 and 34.9. Our analyses suggest that, for women who breastfed for the

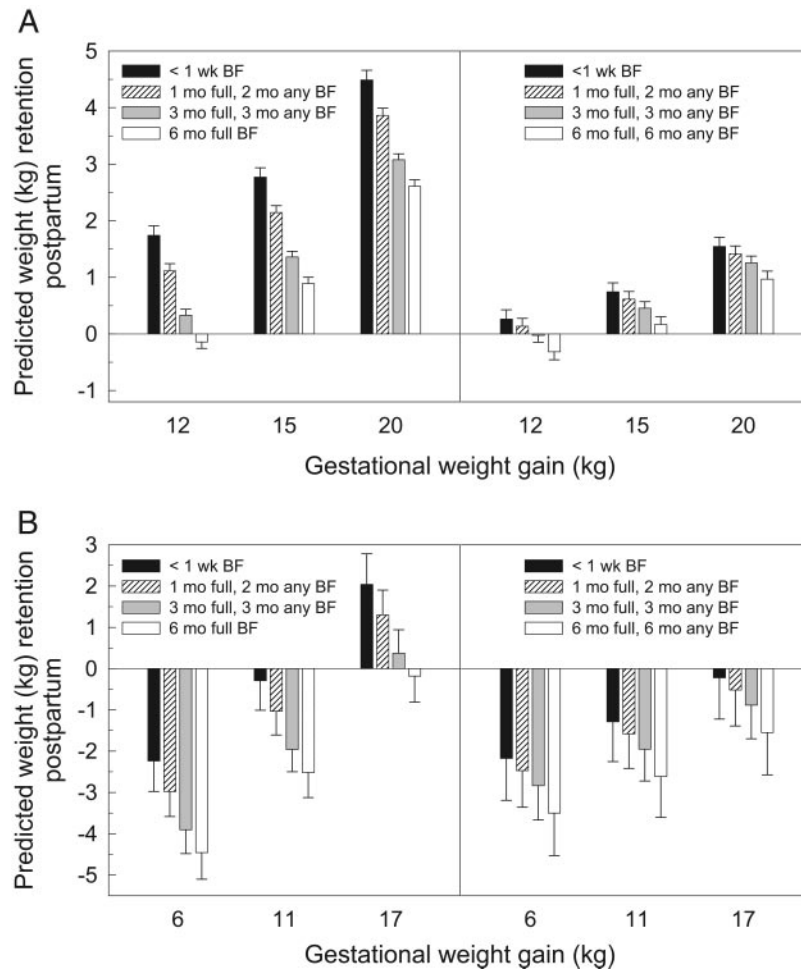


FIGURE 2. Predicted weight retention at 6 mo (left panels) and 18 mo (right panels) among normal-weight (A) and obese (B) women by gestational weight gain and breastfeeding (BF) patterns according to percentiles of gestational weight gain (20th, 50th, and 80th percentiles) and BF patterns. Significant interactions between prepregnancy BMI and BF were not identified (*see* Results section and Table 3 for details of the predictions).

recommended duration and intensity (28, 39) and who gained weight reasonably (ie, ≈ 12 kg) during pregnancy, breastfeeding could also make a meaningful contribution, eliminating PPWR by 6 mo postpartum in many women.

The DNBC had many advantages for the present investigation. It is a contemporary cohort with a large sample size that provided adequate statistical power for analyses across the range of prepregnancy BMI values. The data were collected prospectively, with particular attention to the progress of breastfeeding, a characteristic that distinguishes the present cohort from most others. It is of particular importance that the DNBC was carried out in a society in which breastfeeding is the norm—exclusive breastfeeding in Denmark usually lasts for 15–16 wk, until the time at which Danish health authorities recommend that solid foods be introduced to the infant's diet, and partial breastfeeding usually continues until or even beyond the end of the maternity leave, which is ≥ 24 wk.

The DNBC is the best resource currently available for data on both adequate intensity and duration of breastfeeding, but it has limitations. Its sample consists nearly entirely of white women, and thus it is not known whether the findings obtained in the present study are applicable to women of other racial-ethnic groups. The Danish context means that a high proportion of

women breastfed, but it also means that a small proportion ($< 2\%$) of women did not breastfeed at all. As a result, we were unable to conduct a reliable analysis that included these non-breastfeeders. Inasmuch as the DNBC consisted primarily of data collected by telephone interview, it lacked measured data on prepregnancy or postpartum weight or GWG. Nonetheless, the weight values were reported close to the time at which they were measured, and any imprecision in the reports of these values would attenuate the results of the analyses.

An inconsistency in findings—and thus the controversy about the relation between breastfeeding and PPWR—could have resulted from inadequate measures of lactation duration and intensity, small sample sizes, high dropout rates, and the inclusion of dieters in the nonbreastfeeding group, as well as a failure to control for confounding by the maternal characteristics according to Gunderson and Abrams (40). In addition, a failure to find a relation between breastfeeding and PPWR could have resulted from the relatively short duration and low intensity of breastfeeding that is characteristic of US women (41).

In the present study, we expressed the association between breastfeeding and PPWR in relation to the degree of breastfeeding. This approach reflects the fact that producing more milk requires additional energy and, in the absence of restriction of

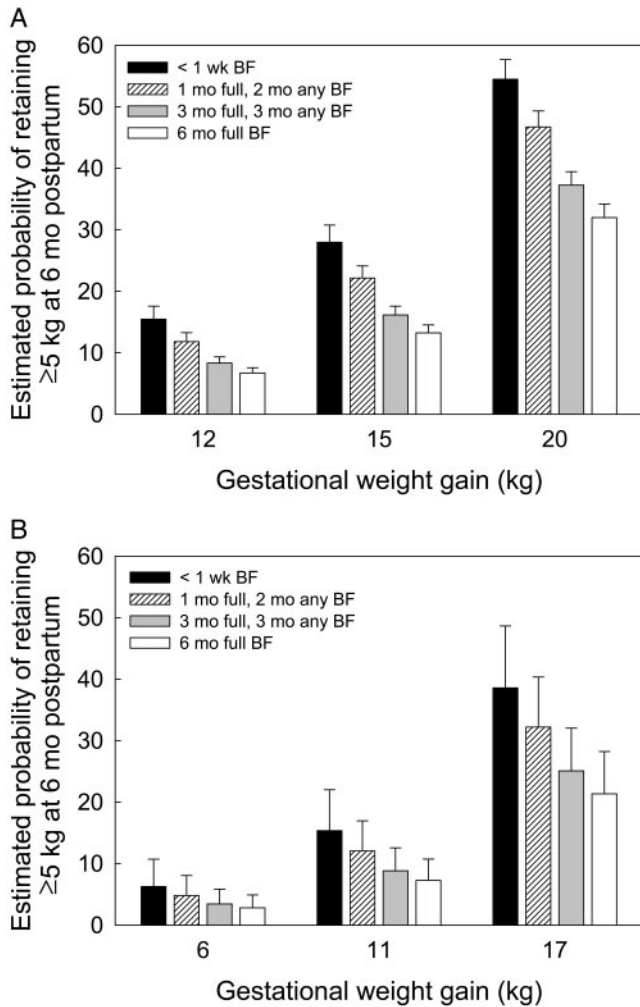


FIGURE 3. Risk of retaining ≥ 5 kg of gestational weight gain (GWG) at 6 mo postpartum among normal-weight (A) and obese class I (B) women by GWG and breastfeeding (BF) patterns according to percentiles of GWG (20th, 50th, and 80th percentiles) and BF patterns. Significant interactions between prepregnancy BMI and BF were not identified (see text for details of the construction of the risk predictions).

food intake or changes in physical activity, should lead to greater weight loss. Duration of breastfeeding alone does not adequately capture this biological relation. Öhlin and Rössner (26) assigned 4 or 2 points for every month of full or partial breastfeeding, respectively. In their analysis of data from 1423 Swedish women who were studied from 2.5 to 12 mo postpartum, lactation score was significantly associated with weight retention, but it explained little of the variance in PPWR. Women with a higher lactation score (ie, ≥ 20) lost significantly more weight from 2.5 to 6 mo postpartum, but not from 2.5 to 12 mo postpartum, than did women with a lower lactation score (0–19). Unfortunately, Öhlin and Rössner excluded the period from birth to 2.5 mo, which is characterized by both the greatest intensity of breastfeeding and the greatest rate of postpartum weight loss.

We used the detailed information on infant feeding available in the DNBC to construct our lactation score. In an approach consistent with that used to develop the estimated energy requirement for lactating women (35), we weighted full breastfeeding as twice partial breastfeeding during the first 12 mo postpartum in

our score. However, after 12 mo, the score for partial breastfeeding was halved to reflect the continued decrease in intake of human milk by infants as additional solid foods were added to their diets. This approach permitted us to consider breastfeeding behavior as a continuous variable, an approach that is statistically more powerful than is categorizing this behavior. This approach also permitted us to consider the separate contributions of full and partial breastfeeding together instead of using only one or the other. This is important, because the behaviors are correlated, and using one or the other alone underestimates that total contribution of breastfeeding. With this approach, we found that weight retention decreased with increasing lactation score in every prepregnancy BMI group at 6 mo and in normal-weight, overweight, and obese class I women at 18 mo.

Janney et al (42) used longitudinal data for 110 US women to construct 4 patterns of breastfeeding practice that reflected both the duration and intensity of breastfeeding. They found that women who breastfed achieved their prepregnancy weight ≈ 6 mo earlier than did women who only bottle-fed their infants (42). Nonetheless, they concluded that, as a means of minimizing PPWR, only limited emphasis on breastfeeding was warranted. The results of the present study suggest a different conclusion. The relatively long duration of exclusive and any breastfeeding by the participants in the DNBC permitted us to construct statistically adequate prediction models of the potential contribution of breastfeeding to the reduction of PPWR. A unique contribution of our research is to show that, if women breastfeed their infants as recommended (28, 39), breastfeeding could potentially eliminate PPWR by 6 mo postpartum in women with reasonable GWG. In addition, our results show that, with the exception of the heaviest women, those with reasonable GWG who breastfeed their infants as recommended could greatly reduce the risk of major weight retention (≥ 5 kg) at 6 mo postpartum. Because there were few women in the obese class II and III category, which covered a wide range of prepregnancy BMI values (ie, 35.0–55.4), the lack of a detectable effect of breastfeeding in the heaviest women may result from inadequate statistical power rather than from a biological difference.

Although our new findings give greater importance to the potential contribution of breastfeeding to the reduction of PPWR, even breastfeeding according to the recommendations is insufficient to counter the effects of high GWG. Thus, gaining a reasonable amount of weight during pregnancy remains an essential element in reducing PPWR. Keeping GWG at a reasonable level will be a challenge, because 38% of US women currently gain more than the recommended amount during pregnancy (43).

Unfortunately, US women are not breastfeeding as recommended (41). Many sociodemographic and psychosocial factors are associated with early cessation of breastfeeding (44, 45) and thus are potential targets for intervention. In addition, many US women of reproductive age are heavy. This is a problem because the duration and intensity of breastfeeding are negatively associated with prepregnancy BMI in US (46–48) and Danish (29) women. Women with BMI values > 30 , a group that currently comprises 29% of women of reproductive age (1), may need additional assistance to increase the duration and intensity of breastfeeding (29). Nonetheless, breastfeeding reduced PPWR in all but the heaviest women, and thus it represents a behavior that physicians can promote to help most women avoid PPWR.

In addition to the large body of research that supports the benefits of breastfeeding for the health of the infant (28), our findings suggest that breastfeeding can contribute to maternal health by reducing PPWR. The duration and intensity of breastfeeding that are necessary to achieve this benefit will require more commitment to breastfeeding in US women, their families, their healthcare providers, and society than has historically been the case.

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