

PAPER

Prospective assessment of exclusive breastfeeding in relation to weight change in women

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OBJECTIVE: To study prospectively the relation of parity, prepregnancy body mass index (BMI), and exclusive breastfeeding to weight gain.

DESIGN: The cohort of the Nurse's Health Study II, with analysis restricted to women who were aged 24 to 40 y at baseline (1989), who had a history of no more than one past full-term pregnancy at baseline, gave birth to one child between 1990 and 1991, but had no other pregnancies during the follow-up.

SUBJECTS: 1538 of the 33 082 nulliparous women and 2810 of the 20 261 primiparous, in 1989.

MEASUREMENTS: Introduction of daily formula/milk was assumed to represent the end of exclusive breastfeeding period. Duration of exclusive breastfeeding was categorized into 0, 1–3, 4–7, 8–11, and 12 months or more.

RESULTS: After adjusting for age, physical activity, and BMI in 1989, lactation was associated with a weight gain from 1989 to 1993 of approximately 1 kg (statistically significant only for women nulliparous in 1989 with a BMI < 25 kg/m² ($P = 0.02$) and for those women primiparous in 1989, with a BMI ≥ 25 kg/m² ($P = 0.04$)) comparing women who breastfed with women who did not, and duration of lactation was unrelated to the magnitude of weight change ($P > 0.40$ for all comparisons).

CONCLUSIONS: Although promotion of breastfeeding has high priority because of its enormous advantages for a newborn child, the associated maternal weight reduction is minimal. Dietary guidelines for pregnant and breastfeeding women should include ways to prevent weight retention after parity.

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Introduction

Changes in body weight associated with breastfeeding are highly variable. Butte and Hopkinson¹ reviewed 19 studies from developed and developing countries and concluded that most reports show no differences in weight change between lactating and nonlactating women; however, only six of these studies followed women for more than 3 months.

Even undernourished women have a fat deposition of about 2 kg by the end of pregnancy.² The neuroendocrine changes associated with lactation, characterized by episodic secretion of prolactin and oxytocin, suppression of the hypothalamic–pituitary–gonadal axis, and hypoinsuline-

mia,³ can conserve energy and spare substrate for milk production. Early in breastfeeding, the child's energy needs are small and a positive maternal energy balance is possible, thus, the duration of breastfeeding may be important in any study of weight reduction after pregnancy.

Women overweight before pregnancy generally gain less weight, but retain more weight postpartum.⁴ Thus, body mass index (BMI) prior to pregnancy may modify the association between weight change and breastfeeding as shown in a cross-sectional analysis of a population-based Brazilian survey.⁵ In that study, weight change associated with breastfeeding was dependent on BMI prior to pregnancy; overweight women gained weight and lean women lost weight with breastfeeding, but the interaction between prepregnancy BMI and breastfeeding has not been explored in most studies.

Additional limitations in most studies of the relation between parity or breastfeeding and weight gain include lack of information on prepregnancy weight, inadequate control

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of other factors associated with postpartum weight change such as physical activity and smoking, and a crude measurement of breastfeeding. Most studies combine the breastfeeding history from all pregnancies, when the important question is the effect of each pregnancy and duration of breastfeeding needed to offset the weight gain related to pregnancy.

Using data collected in The Nurses' Health Study II that allowed us to address most of these methodological issues, we studied the relation of parity, prepregnancy BMI, and breastfeeding to weight gain.

Methods

Population sample

The Nurses' Health Study II was established in 1989 when 116 671 female registered nurses responded to a mailed questionnaire about their parity, medical history, and lifestyle. Since then the cohort has been followed up every 2 y to ascertain incident diseases and exposures including parity and body weight. Individual breastfeeding data were collected retrospectively in the 1997 follow-up.

For the present study, the sample was restricted to women aged 24–40 y in 1989, who were not pregnant at baseline, had a history of no more than one full-term pregnancy in 1989, and who gave birth to one child in 1990 or 1991, and had no other pregnancies during the 1989–1993 follow-up. Those who reported use of insulin, hypoglycemic drugs, or thyroid disease at baseline or follow-up were excluded from analysis (1914 nulliparous and 1265 primiparous at baseline (Table 1). From the 33 082 women who were nulliparous in 1989, 1538 met the inclusion criteria and were included in the analysis and from the 20 261 primiparous at baseline, 2810 met the inclusion criteria and were included (Table 1).

Variable definitions

We analyzed weight change between 1989 and 1993 according to breastfeeding duration of the child who was born between 1990 and 1991. Analyses were stratified by BMI at baseline (BMI <25 kg/m² and BMI ≥25 kg/m²) and by parity at baseline (nulliparous and primiparous).

In 1997, women were asked to recall their lifetime breastfeeding history. For each birth, women were asked if they had breastfed for at least a month and if so they were asked to report the month in which they introduced the formula. If the answer to the question 'Did you breastfeed at least one month?' was 'no, not at all', the duration was considered as zero. Otherwise, breastfeeding duration for each pregnancy was defined by combining these two questions and parity data from 1991 and 1993 questionnaires. Introduction of daily formula/milk was assumed to represent the end of exclusive breastfeeding period. Duration of exclusive breastfeeding was categorized into 0, 1–3, 4–7, 8–11, and 12 months or more.

Description and validation of the eight-question physical activity questionnaire used in 1989 and 1991 have been published elsewhere.⁶ In 1993, the physical activity assessment was limited to months engaged in strenuous physical activity.

Correlations between body weight assessments were 0.90 for the first interval of follow-up (1989 vs 1991), 0.91 for 1991 vs 1993 and 0.92 for 1989 vs 1993.

Statistical analysis

To assess whether women who breastfed were different in terms of their weight changes than women who did not, weight change from prepregnancy (1989) to postpregnancy (1993) was estimated according to exclusive breastfeeding duration using linear regression models. Statistical models were adjusted for age, physical activity in 1989, physical

Table 1 Exclusion criteria for nulliparous and primiparous women in 1989

	Nulliparous	Primiparous
	N	N
Women 24 to 40 y in 1989	33 082	20 261
<i>Exclusions</i>		
Diabetes or thyroid diseases in 1989	1220	807
Pregnant in 1989	1709	1938
Pregnant in 1992–1993	4741	2709
Diabetes or thyroid diseases 1989–1993	694	458
Inconsistency between parity/lactation (women reported births and did not answer lactation questions or v.v.)	367 (2.6% of total births)	547 (3.1% of total births)
Had no child in 1991–1992	21 338	10 210
More than one child in 1991–1992	1471	770
<i>Included in the analysis</i>	1538 ^a	2810 ^a

^aAfter excluding four nulliparous and 12 primiparous with BMI missing at baseline.

Table 2 Means and percentages of selected characteristics, according to duration of breastfeeding in women nulliparous at baseline

	Breastfeeding duration					P-value
	Never	<3 months	4–7 months	8–11 months	>12 months	
Number of women	216	749	316	117	140	
Age-mean in 1989 (y)	29.7	30.2	30.4	30.2	31.2	0.007
Energy intake (kcal/day)	1868	1904	1931	2116	2028	0.0005
Fat intake (g/day)	65	65	64	68	65	0.74
Physical activity in 1989 MET/week	33.0	28.2	36.8	35.0	33.1	0.07
Activity change 1989–1991						
Percent increased ^a	15.3	14.3	16.5	16.2	16.4	0.60
Percent decreased ^a	34.7	36.3	41.2	37.6	40.7	
BMI >25 kg/m ² in 1989 (%)	27.8	18.4	15.8	17.9	10.7	0.0006
Current smoker—1989 (%)	12.9	12.3	9.4	3.4	7.1	0.02
Current smoker—1991 (%)	8.8	7.7	5.7	4.3	1.4	0.03
Current smoker—1993 (%)	9.3	9.1	7.6	4.3	2.1	0.03

^aVariation greater than 10 METS/week.

activity change 1989–1991, and BMI in 1989. Models excluded women who reported smoking at baseline or follow-up. Since weight change values were skewed, we used log transformation to normalize the data; the smallest negative weight difference was added to each weight change value to avoid zero value. After modeling, the adjusted coefficients were backtransformed by taking the exponential.

Since we did not have weight at the end of pregnancy, we could not evaluate separately weight change during pregnancy or after pregnancy for each woman. However, we conducted a secondary analysis to estimate the average weight gain from baseline to pregnancy (1991)—period I, and the average weight reduction after pregnancy (1993 compared to 1991)—period II, among women currently pregnant at the 1991 follow-up. These longitudinal models were based on mixed effects analysis (Proc mixed SAS-version 8.0,⁷), with the 1991 follow-up treated as the time comparison group. Weight change for both periods was tested by the interaction between time (1989, 1991, and 1993) and breastfeeding duration, thus groups with parallel segments had similar weight change. These models permitted us to test differences in prepregnancy weight at baseline (group effect), weight gain with pregnancy (time-dependent effect of period I), and weight change after pregnancy (time-dependent effect of period II), by breastfeeding status. If breastfeeding groups differed at baseline but had the same change in weight during follow-up, a group effect but not a time-dependent effect would be seen.

Results

Among women who were nulliparous at baseline, duration of breastfeeding was positively associated with age and energy intake, and negatively associated with prepregnancy BMI and smoking status (Table 2). Data for primiparous

women at baseline followed the same pattern (data not shown).

Overall, women primiparous at baseline gained less weight between 1989 and 1993 than nulliparous women at baseline, and women overweight at baseline gained more weight than women with BMI <25 kg/m² in 1989. For women who weighed <25 kg/m² at baseline, those who were nulliparous on average gained 2.9 kg by 1993 (Table 3), and primiparous women gained 2.2 kg by 1993 (Table 4). For women with a BMI ≥25 kg/m² at baseline, nulliparous women gained 6.7 kg (Table 3), and primiparous women gained 4.2 kg (Table 4). Among nulliparous women in 1989 who were normal weight (BMI <25 kg/m²), average weight gain from 1989 to 1993 was 2.1 kg for those who never breastfed, it varied from 2.8 to 3.3 kg for those who breastfed from 1 to 11 months, and it was 2.2 kg for those who breastfed exclusively ≥12 months (Table 3). For women primiparous in 1989 (Table 4), as well as for nulliparous overweight women at baseline (Table 3), changes in body weight by duration of breastfeeding were less striking.

Adjustment for age, physical activity in 1989, change in physical activity from 1989 to 1991, and BMI in 1989 did not materially change the results (Tables 3 and 4). Overall, breastfeeding was associated with a weight gain of approximately 1 kg comparing women who breastfed with women who did not. These small weight changes were statistically significant only for women nulliparous in 1989 with a BMI <25 kg/m² (*P*-value 0.02) (Table 3), and for women primiparous in 1989 with a BMI >25 kg/m² (*P*-value 0.04) (Table 4). The association between breastfeeding duration and weight change was also evaluated in analyses where breastfeeding was modeled as a continuous variable, and after exclusion of those women who never breastfed (*P*>0.40 for all groups) (data not shown).

To explore further the weight gain in breastfeeding women compared to nonbreastfeeding women, we analyzed the average weight change from baseline to pregnancy (1991)

Table 3 Unadjusted mean body weight (kg) in 1989, unadjusted weight gain from 1989 to 1993, and adjusted^a mean difference in weight change, in nonpregnant women at baseline who gave birth to their first child in 1990–1991, according to duration of breastfeeding

	N	Weight	Weight gain		Adjusted difference in weight change	
			Mean	s.d.	(kg)	P-value
<i>BMI < 25 kg/m² in 1989</i>						
Never	156	57.1	2.1	4.1	0 (reference)	
1–3 months	611	58.1	3.2	4.8	1.02	0.04
4–7 months	266	58.2	3.3	4.4	1.03	0.01
8–11 months	96	59.1	2.8	3.6	1.02	0.13
≥12 months	125	57.7	2.2	3.4	1.02	0.21
All	1254	58.0	2.9	4.4	1.02 ^b	0.02
<i>BMI ≥ 25 kg/m² in 1989</i>						
Never	60	80.8	6.7	9.2	0 (reference)	
1–3 months	138	80.6	6.4	9.8	0.91	0.30
4–7 months	50	80.6	7.7	12.1	0.99	0.91
8–11 months	21	80.8	4.2	6.4	0.91	0.51
≥12 months	15	76.1	8.4	8.4	0.99	0.97
All	284	80.4	6.7	9.8	0.93 ^b	0.41

^aAdjusted for age, physical activity in 1989, physical activity change, and BMI in 1989 and excluding smokers.^bAny breastfeeding duration/never.**Table 4** Unadjusted mean body weight (kg) in 1989, unadjusted weight gain from 1989 to 1993, and adjusted^a mean difference in weight change, in primiparous nonpregnant women at baseline who gave birth to a child in 1990–1991, according to duration of breastfeeding

	N	Weight	Weight gain		Adjusted difference in weight change	
			Mean	s.d.	(kg)	P-value
<i>BMI < 25 kg/m² in 1989</i>						
Never	367	58.5	2.4	4.5	0 (reference)	
1–3 months	975	58.3	2.1	3.8	0.99	0.28
4–7 months	443	58.0	2.4	4.1	0.99	0.65
8–11 months	182	57.5	2.1	3.3	1.00	0.91
≥12 months	217	57.5	2.2	5.1	0.99	0.77
All	2184	58.1	2.2	4.1	0.99 ^b	0.43
<i>BMI ≥ 25 kg/m² in 1989</i>						
Never	167	80.2	3.3	8.3	0 (reference)	
1–3 months	285	77.8	4.4	7.7	1.08	0.07
4–7 months	99	77.9	4.2	8.3	1.06	0.28
8–11 months	37	78.4	3.0	7.9	1.06	0.42
≥12 months	38	79.7	7.7	7.4	1.18	0.03
All	626	78.6	4.2	8.0	1.09 ^b	0.04

^aAdjusted for age, physical activity in 1989, physical activity change, and BMI in 1989, and excluding smokers.^bAny breastfeeding duration/never.

and from pregnancy (1991) to 1993 among women who were currently pregnant at the 1991 follow-up. Since there was little difference in weight gain among intermediate durations of breastfeeding, for this analysis we collapsed the breastfeeding groups into never, 1–11 months and ≥12 months (Figure 1). Among women with BMI <25 kg/m² in 1989, both breastfeeding groups showed a statistically significant postpartum weight reduction compared to the never breastfed group (weight loss associated with ≥12 months of breastfeeding was 1.09 kg and with 1–11 months of breastfeeding it was 1.04 kg). In contrast, among women

who were overweight in 1989, postpartum weight change was unrelated to breastfeeding. Results were almost unchanged with further adjustment for energy intake and change in physical activity (data not shown). In models that included both nulliparous and primiparous women in 1989, nulliparous gained 1.05 kg more than primiparous ($P = 0.005$).

Discussion

Our results suggested that the effect of breastfeeding on maternal weight is negligible. Overall, women who breastfed

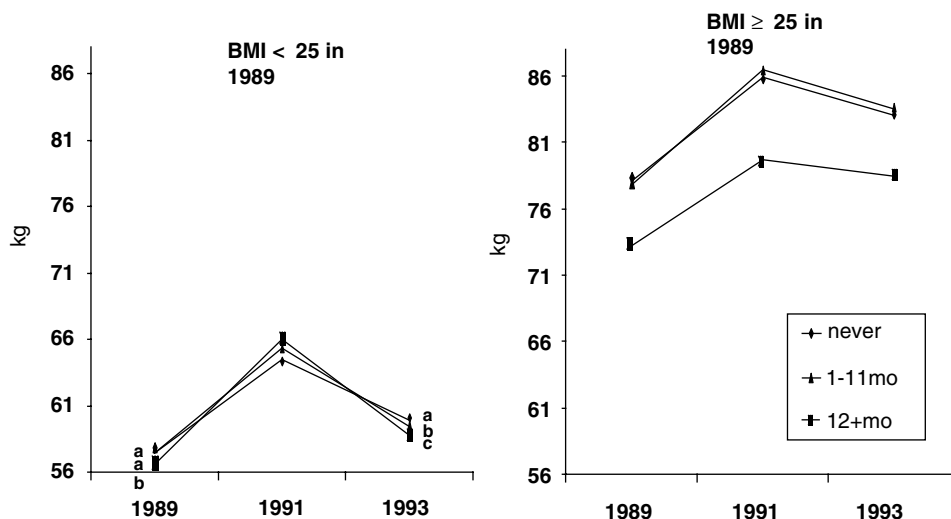


Figure 1 Mean weight change from 1989 to 1991 and from 1991 to 1993, by breastfeeding categories, combining nulliparous and primiparous women at baseline, restricted to women currently pregnant in 1991. Models adjusted for parity, and age. Smokers excluded. Mixed models testing differences in weight change between 1989–1991 and 1991–1993 have lines with different letter if *P*-values < 0.05.

gained about 1 kg more from pre-pregnancy to at least 1 year post-pregnancy compared with women who did not breastfeed.

Although our results for the long-term effect of breastfeeding on weight change are straightforward, the secondary analysis has limitations since we combined weight gain for pregnant women in 1991 at differing weeks of gestation. Therefore, the group means are not an actual estimate of weight achieved from baseline to the end of pregnancy. Nevertheless, it appears plausible to assume a random variation of the pregnancy length, allowing us to compare the weight changes among the groups.

The literature documents a highly variable range of maternal weight change with breastfeeding. In a review of 26 prospective and cross-sectional studies conducted in different countries the mean postpartum weight change associated with lactation ranged from a loss of 14% to a gain of 10%.⁸ A review restricted to prospective studies found weight reduction in 14 out of 17 studies, but most of them had follow-up periods of less than 6 months (weight change ranged from -2.25 kg/month to $+0.20$ kg/month for developed countries, and from -0.80 kg/month to $+0.79$ kg/month for developing countries¹).

Our findings showed that women who breastfed for longer periods are less likely to smoke cigarettes and are more likely to quit if they smoked before pregnancy. They are also less likely to be overweight prior to pregnancy (BMI ≥ 25 kg/m² = 10.7% vs 27.8% in the group who never breastfed), but they consumed more calories in 1991 and gained more weight from baseline to pregnancy. Taken together, these findings may help to explain the highly variable changes in weight associated with breastfeeding found in the studies that did not control for many of these factors. In addition, most studies that have estimated weight change related to breastfeeding have not adjusted for or stratified by previous

BMI, an important methodological step as shown in the present analysis and other studies.^{5,9} In a longitudinal study that controlled for previous BMI, Janney *et al*⁹ followed 110 American women monthly, from delivery to 18 months postpartum, and showed results consistent with ours. A weight retention of about 1 kg comparing nonlactating with lactating women was observed and the authors concluded that the effect of breastfeeding was too limited to recommend breastfeeding as a way of reducing weight retention after pregnancy.

Weight gain or lack of weight loss during breastfeeding is not an unexpected phenomenon. The drop in the maternal leptin level after birth, as reported by Shubring,¹⁰ and Pickavance,¹¹ and the increase in prolactin early in lactation are associated with increased energy intake. In contrast, Butte *et al*¹² found no differences in the leptin levels of lactating and nonlactating women. Changes in the insulin sensitivity¹³ and estrogens¹⁴ are also consistent with an increased appetite and energy sparing during breastfeeding.

Our data indicate that overweight women before pregnancy retain a substantial amount of weight (about 7 kg) after pregnancy, independent of the duration of breastfeeding. Thus, maternal weight change associated with breastfeeding is minimal among normal weight women, and for overweight women the weight gained during pregnancy is not reduced by breastfeeding. While there are many positive benefits to breastfeeding, our data indicate that postpartum weight loss is not among them.

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