

Breastfeeding and postpartum weight retention in a cohort of Brazilian women^{1–3}

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ABSTRACT

Background: The relation between postpartum weight retention and breastfeeding practices is controversial.

Objective: Defining breastfeeding as the period when a child is exclusively or predominantly breastfed, we studied the association between breastfeeding duration and postpartum weight retention.

Design: We followed 405 women aged 18–45 y who were assessed at 0.5, 2, 6, and 9 mo postpartum. The outcome variable, postpartum weight retention, was expressed as the difference between the observed weight at each follow-up and the reported prepregnancy weight. The main statistical procedure used was the longitudinal mixed-effects model.

Results: Mean postpartum weight retention at the end of the study was 3.1 kg. Single women aged ≥ 30 y retained more weight than did younger single women or married women. The combined effect of breastfeeding duration and percentage of body fat at baseline was significant only for women with $< 30\%$ body fat. According to the model's prediction, when women who had 22% body fat and breastfed for 180 d were compared with those who had 22% body fat and breastfed for only 30 d, each month of breastfeeding contributed -0.44 kg to postpartum weight retention. When only the percentage of body fat was varied, the total effect was 3.0, 1.7, 1.2, and 0.04 kg in women with 18%, 25%, 28%, and 35% body fat, respectively.

Conclusions: These results support the hypothesis of an association between breastfeeding and postpartum weight retention and suggest that encouraging prolonged breastfeeding might contribute to decreases in postpartum weight retention. *Am J Clin Nutr* 2004; 79:487–93.

KEY WORDS Breastfeeding, lactation, postpartum weight retention, maternal obesity, women of childbearing age, follow-up study, longitudinal regression

INTRODUCTION

Recent field research in Brazil has indicated that obesity is an important public health problem (1, 2) because of the number of people affected and the associated chronic and metabolic conditions, such as cardiovascular diseases and diabetes (3, 4). Monteiro (1) reported an annual increase from 1974 to 1989 of 0.2% in the prevalence of overweight among women. From 1989 to 1996 the annual increase was even greater (0.37%). Given these background data showing the increasing public health importance of overweight and obesity, postpartum maternal weight retention appears relevant, although it has not been sufficiently studied in the Brazilian population (5–7), specifically in relation to breastfeeding practices.

Robinson (8) suggests that fat deposits develop during gestation in anticipation of the later use of this energy content during lactation. These changes occur in response to a complex sequence of neuroendocrine and biochemical stimuli that start with conception and undergo modulation by environmental constraints. Robinson's observations notwithstanding, several studies on the potential effect of lactation on maternal weight retention have produced conflicting results. For example, no such association was observed by Brewer et al (9) or by Dugdale and Eaton-Evans (10). On the other hand, another group of studies showed that lactation had only a weak protective effect that was restricted to a specific period of time (11–13). In the present study, we followed a cohort of 405 women aged 18–45 y for 9 mo after delivery and collected data at 4 time points to assess the association between breastfeeding duration and postpartum weight retention by using random-effects, longitudinal linear regression techniques.

SUBJECTS AND METHODS

Recruitment and selection of study participants

We enrolled and followed for 9 mo a cohort of Brazilian women aged 15–45 y who lived in the municipality of Rio de Janeiro. Data collection lasted 24 mo (15 mo for recruitment plus 9 mo of follow-up) from May 1999 to April 2001. A total of

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709 women were recruited during this period, and 479 were enrolled in the cohort. A total of 74 women were excluded on the basis of the criteria listed below. Thus, the final sample consisted of 405 women who were followed longitudinally for 9 mo, during which time data were collected approximately 15 d after parturition and at 2, 6, and 9 mo after parturition. In terms of age, reported prepregnancy weight, parity, and education, the women who were not enrolled in the cohort had a similar profile to those who were enrolled.

All participants were volunteers, were of childbearing age, and were recruited at 3 different points in time and space: 1) at the principal maternity hospital in the study area immediately after giving birth, 2) during routine prenatal care, and 3) at the time of routine bacillus Calmette-Guérin immunization. Prenatal care and bacillus Calmette-Guérin immunization were performed at a local health center where the study was conducted. Three interviewers who had been trained according to a standardized protocol collected the data. The study was approved by the appropriate research ethics committees (Federal University of Rio de Janeiro and São Paulo University), and signed informed consent was obtained from each study participant.

Eligibility and exclusion criteria

Eligibility criteria for enrollment in the cohort were as follows: women aged 15–45 y, time elapsed since parturition < 30 d at the time of first interview, absence of chronic diseases, gestational age at time of birth \geq 35 wk, no previous history of twin births, and household address within the catchment area of the local health center. Women aged < 18 y ($n = 47$) were excluded from the final sample. Other exclusion criteria were lack of information on prepregnancy weight ($n = 13$) and postpartum weight retention values outside the range of -10.0 to $+16.0$ kg ($n = 14$), which were considered biologically improbable. A total of 74 women were thus excluded from the study.

Outcome variable and time-dependent covariates

Postpartum weight retention, breastfeeding duration, and time since parturition (expressed in days) are time-dependent covariates because they change at each observational point. Postpartum weight retention was the outcome variable and was defined as the absolute difference between the women's weight measured at each interview and their reported prepregnancy weight. This random variable was assumed to be continuous with approximately normal distribution. The modeling approach assumes the outcome variable as a linear combination of explanatory covariates.

We measured body weight with the use of a digital scale (model PL 150; Filizola S/A, São Paulo, Brazil) that was accurate to 0.1 kg. The women wore no shoes and were dressed only in light clothing. We measured height at the first follow-up with the use of a Harpenden & Holtain stadiometer (Harpenden Inc, Crymch, Pembrokeshire, United Kingdom) that was accurate to 0.1 cm. Each woman stood upright with her head on the Frankfort plane. All measurements were performed by 2 trained anthropometrists according to standardized procedures (14). The 2 measurements together allowed the calculation of the body mass index [BMI = weight (in kg)/height² (in m)].

The covariate time since parturition was defined as the time interval in days between the date of each interview and the date

of delivery. The covariate lactation was defined according to guidelines from the World Health Organization/United Nations Children's Fund (15) as follows: 1) exclusive breastfeeding, when the child received no water, tea, juice, or food; 2) predominant breastfeeding, when the child received water, tea, or juice but no food; 3) partial breastfeeding, when the child received artificial milk or water, tea, juice, or food; and 4) artificial feeding, when the child received no breastfeeding. We used these guidelines (15) to derive our main explanatory covariate, breastfeeding duration, which was expressed in days.

We measured percentage of body fat by using impedance at all interviews. However, in the present study, we assessed the explanatory power of the information at the beginning of the follow-up period, ie, 15 d after delivery. Body composition was measured with the use of a BIA 101Q (RJL Inc, Clinton Township, MI) according to the manufacturer's guidelines. Obesity was defined as a percentage of body fat \geq 30%. This cutoff was chosen because it has been systematically used as a definition of obesity among women (16), because it represents the 90th percentile of body fat distribution for a random Swiss sample measured by impedance (17), and because there is no clear agreement on a definition of obesity for postpartum women.

Time-independent covariates

Time-independent covariates are so labeled because they were time invariant over the course of the study period. In our analysis, we selected the following time-independent covariates: marital status (married, with partner, single), age category at baseline (18–19, 20–29, 30–45 y), reported prepregnancy weight, prepregnancy BMI, height, skin color category (black, mulatto, white), place of birth (state of Rio de Janeiro, other state in Brazil), residential stratum (rural, urban), smoking (current smoker, past smoker, never smoker), schooling (≤ 4 , ≥ 5 y), and parity (1, 2, 3, ≥ 4).

Losses to follow-up

The pattern of losses to follow-up is described in Kac (7) and in Kac et al (18). The women were compared by using the final follow-up rate for several variables including age, total family income, smoking status, prepregnancy weight, height, body fat, and weight retention at the first interview. The chi-square test for proportions was used to assess patterns of nonrandom losses to follow-up.

Longitudinal models

We fitted longitudinal, mixed-effects linear regression models (19) to investigate the effect of breastfeeding duration on postpartum weight retention during the 9 mo after parturition. The longitudinal aspect of the study design allowed us to describe patterns of change over time. Contrary to repeated-measures analysis of variance, longitudinal mixed-effects linear regression models can accommodate time-dependent and time-independent covariates and unbalanced time intervals as well as allow for different correlation structures among the repeated measures.

In our models, postpartum weight retention was the outcome variable, and we used function lme in SPLUS 2000 (MathSoft, Inc, Cambridge, MA) (19) for model fitting. The variable time since parturition functioned as the independent variable that drove the behavior of postpartum weight retention over time and thus was included in all longitudinal models that were fitted. Both

this variable and breastfeeding duration were modeled as random effects to allow individual variation in postpartum weight retention over time. We ran all models with and without random effects, and the differences observed in the variable estimates were considered important enough to keep the random-effects coefficients in the models.

Autocorrelation structure

When longitudinal data are analyzed, any 2 observations are assumed to be independent from one another, while the residuals within each woman are correlated with one another. We specified an exponential correlation structure in our models to control for the irregular time intervals (0.5, 2, 6, and 9 mo) at which postpartum weight retention was measured. Thus, the correlation between any 2 adjacent measurements tends toward zero as the time between measurements increases.

Statistical modeling

We first fitted bivariate linear regression models of postpartum weight retention, as the outcome variable, against the explanatory variables (time since parturition, breastfeeding duration, prepregnancy weight) 2 at a time. The interaction term between prepregnancy weight and time since parturition was also tested. We then fitted multivariate longitudinal models to assess important predictors of postpartum weight retention over time. Eligible variables for entering the model were as follows: age at baseline, breastfeeding duration, marital status, height, prepregnancy BMI, prepregnancy weight, percentage of body fat at baseline, skin color category, mother's place of birth, residential stratum, smoking status, schooling, and parity.

The model was constructed step by step. Initially, a model with only main effects was built. Only variables that were significant at $P < 0.20$ under bivariate modeling and with no interaction were included. Biologically plausible interaction terms were then considered one at a time for inclusion in the main-effects model. Interaction terms that were significant at $P < 0.15$ were considered as candidates for the final model. Finally, all the interaction terms that were considered candidates for the final model were simultaneously included in the main-effects model. The final model was obtained after backward elimination of main effects and interaction terms from the hierarchically superior model. The presence of an interaction term also implied the presence of all related main effects (hierarchy). Quadratic terms were also tested to account for simple nonlinearities at all steps.

Discrimination between competing models and the choice of

TABLE 1

Time-invariant covariates in Brazilian women aged 18–45 y who lived in the municipality of Rio de Janeiro (1999–2001)¹

Variable	Value
Age (y)	26.2 (25.6, 26.8) [405]
Height (cm)	158.5 (157.9, 159.2) [405]
Prepregnancy weight (kg)	57.2 (56.2, 58.3) [405]
Prepregnancy BMI (kg/m ²)	22.7 (22.4, 23.1) [405]
Schooling (y) ²	6.9 (6.6, 7.3) [356]
Parity (n) ³	2.1 (1.9, 2.2) [299]

¹ \bar{x} ; 95% CI in parentheses; n in brackets.

² Data obtained on the second follow-up visit.

³ Data obtained on the third follow-up visit.

the best model were based on global criteria, such as the Akaike information criterion and log likelihood (19). Along all modeling steps, 3 types of diagnostic graphics were produced: scatter plots of residuals to check for specific patterns, q-q plots to check normality of the residuals, and plots to check the autocorrelation structure. The objective at each step was to identify the best functional form for each variable included in the model.

RESULTS

The analysis of data from the study participants who were lost to follow-up showed no departure from a random process (non-informative) for all the variables except age, which means that the final follow-up rate for women aged > 30 y was higher than that for women aged ≤ 30 y (7, 18) (data not shown). Descriptive statistics regarding the study cohort are presented in **Table 1**. The women in our cohort were relatively young (\bar{x} age: 26 y) and had 6.9 y of schooling (ie, had completed no more than primary school). Mean prepregnancy weight and BMI were 57.2 kg and 22.7, respectively.

The women's weight decreased from 62.0 to 60.8 kg over the course of the study period. BMI remained approximately constant, and percentage of body fat varied $< 1\%$; the greatest reduction in percentage of body fat occurred between 6 and 9 mo of follow-up (**Table 2**). The women with $\geq 30\%$ body fat showed no changes in postpartum weight retention during follow-up (**Table 3**).

The multivariate longitudinal model fitted to the data indicated that breastfeeding duration (in days) was a negative and significant predictor of postpartum weight retention (coeffi-

TABLE 2

Time-variant variables over 9 mo of postpartum follow-up in Brazilian women aged 18–45 y who lived in the municipality of Rio de Janeiro (1999–2001)

Variable	Time since parturition (mo)			
	0.5 ($n = 405$)	2 ($n = 359$)	6 ($n = 298$)	9 ($n = 271$)
Time since parturition (d)	16.9 (16.2, 17.6) ¹	65.9 (65.0, 66.9)	190.5 (189.2, 191.8)	280.7 (279.1, 282.3)
Weight (kg)	62.0 (60.9, 63.1)	61.8 (60.6, 63.0)	61.2 (59.7, 62.6)	60.8 (59.2, 62.4)
Postpartum weight retention (kg)	4.7 (4.3, 5.2)	4.1 (3.6, 4.5)	3.4 (2.9, 4.0)	3.1 (2.5, 3.6)
BMI (kg/m ²)	24.6 (24.2, 25.0)	24.6 (24.1, 25.0)	24.3 (23.8, 24.9)	24.2 (23.6, 24.7)
Body fat (%)	29.5 (28.9, 30.1)	29.7 (29.0, 30.4)	29.1 (28.2, 30.0)	28.2 (27.2, 29.2)
Exclusive breastfeeding (d)	13.0 ²	30.0	30.0	30.0
Predominant breastfeeding (d)	15.0	61.0	105.0	120.0

¹ \bar{x} ; 95% CI in parentheses.

² Median.

TABLE 3

Postpartum weight retention according to selected variables over 9 mo of follow-up in Brazilian women aged 18–45 y who lived in the municipality of Rio de Janeiro (1999–2001)¹

Variable	Time since parturition (mo)			
	0.5	2	6	9
Marital status				
Married	6.0 (4.9, 7.2) [74]	5.0 (3.8, 6.2) [70]	4.2 (3.0, 5.4) [61]	3.5 (2.3, 4.8) [56]
With partner	4.5 (4.0, 5.1) [230]	4.1 (3.5, 4.6) [205]	3.6 (2.9, 4.3) [170]	3.4 (2.6, 4.1) [154]
Single	4.3 (3.3, 5.2) [101]	3.4 (2.4, 4.3) [84]	2.2 (1.1, 3.4) [67]	1.8 (0.5, 3.1) [61]
Age category (y)				
18–19	4.4 (3.3, 5.5) [60]	3.3 (2.1, 4.5) [47]	2.8 (1.1, 4.6) [34]	1.6 (–0.6, 3.7) [24]
20–29	4.6 (4.0, 5.2) [250]	4.0 (3.4, 4.6) [220]	3.2 (2.5, 3.9) [182]	2.8 (2.0, 3.5) [170]
30–45	5.3 (4.5, 6.2) [95]	4.8 (3.9, 5.6) [92]	4.2 (3.1, 5.2) [82]	4.2 (3.0, 5.3) [77]
Breastfeeding practice				
Full or predominant	5.0 (4.5, 5.4) [355]	4.2 (3.6, 4.8) [226]	4.6 (3.5, 5.7) [23]	— (—) [2]
Partial	3.3 (1.8, 4.7) [47]	4.2 (3.4, 5.1) [108]	3.1 (2.1, 4.1) [169]	2.9 (1.9, 3.8) [158]
Bottle feeding	— (—) [3]	2.3 (0.3, 4.4) [25]	3.6 (2.8, 4.5) [101]	3.1 (2.3, 4.0) [111]
Body fat (%)				
< 30	3.5 (3.0, 4.1) [195]	2.5 (2.0, 3.1) [167]	1.4 (0.8, 2.1) [152]	0.8 (0.1, 1.4) [150]
≥ 30	5.9 (5.2, 6.5) [210]	5.4 (4.8, 6.1) [192]	5.5 (4.8, 6.2) [146]	5.9 (5.1, 6.7) [121]

¹ \bar{x} ; 95% CI in parentheses; *n* in brackets. —, very small number of observations.

cient = –0.0388). Additional covariates that were significantly associated with postpartum weight retention were time since parturition (coefficient = –0.0235), age at baseline (coefficient = 0.2985), prepregnancy weight (coefficient = –0.3655), height (coefficient = 0.2524), marital status (coefficient = 5.2384), and percentage of body fat at baseline (coefficient = 0.5484) (**Table 4**).

The interaction between age and marital status was significant in the multivariate longitudinal models (coefficient = –0.1823). In this regard, the women in the study could be grouped into 3 categories of postpartum weight retention according to marital

status and age. The first group consisted of single women aged < 30 y, the intermediate group consisted of married women, and the last group consisted of single women aged ≥ 30 y. The interaction appeared to be stronger in single women than in married women or women with partners (**Figure 1**).

The interaction between breastfeeding duration and obesity is shown in **Figure 2** (coefficient = 0.0011). In summary, breastfeeding had little or no effect on postpartum weight retention in the obese women, whereas in the women with < 30% body fat at baseline, breastfeeding reduced postpartum weight retention.

TABLE 4

Final longitudinal linear regression model for postpartum weight retention in Brazilian women aged 18–45 y who lived in the municipality of Rio de Janeiro (1999–2001)¹

Variable	Regression coefficient	SE	<i>P</i>
Main effect			
Time since parturition (d)	–0.0235	0.0067	0.0006
Breastfeeding duration (d)	–0.0388	0.0113	0.0007
Prepregnancy weight (kg)	–0.3655	0.0243	< 0.0001
Age (y)	0.2985	0.0582	< 0.0001
Height (cm)	0.2524	0.0290	< 0.0001
Marital status ²	5.2384	1.6987	0.0022
Body fat at baseline (%) ³	0.5484	0.0384	< 0.0001
Interaction			
Age × marital status	–0.1823	0.0651	0.0053
Body fat at baseline × breastfeeding duration	0.0011	0.0003	0.0041
Body fat at baseline × time since parturition	0.0006	0.0002	0.0039
Breastfeeding duration × time since parturition	0.0001	0.0000	0.0230
Body fat at baseline × breastfeeding duration × time since parturition	0.00001	0.0000	0.0244
Intercept	–38.5071	4.6658	< 0.0001
Autocorrelation structure: exponential	42.49		
Akayke information criterion	6129.2		
Log likelihood	–3043.6		

¹ *n* = 405.

² Single = 0; married or with partner = 1.

³ Mean of 15 d postpartum.

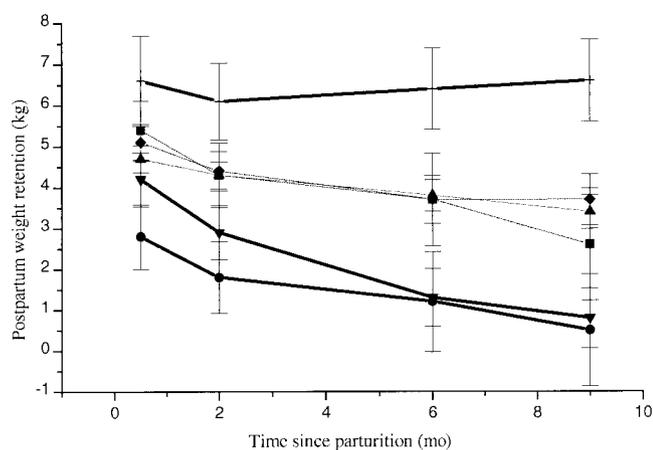


FIGURE 1. Mean (\pm SEM) postpartum weight retention according to age category and marital status in Brazilian women aged 18–45 y who lived in the municipality of Rio de Janeiro (1999–2001). ■, Married and < 20 y old ($n = 37, 29, 22,$ and 16 at 15 d, 2 mo, 6 mo, and 9 mo, respectively); ●, single and < 20 y old ($n = 23, 18, 12,$ and $8,$ respectively); ▲, married and 20–30 y old ($n = 190, 172, 139,$ and $129,$ respectively); ▼, single and 20–30 y old ($n = 60, 48, 43,$ and $41,$ respectively); ◆, married and > 30 y old ($n = 77, 74, 70,$ and $65,$ respectively); +, single and ≥ 30 y old ($n = 18, 18, 12,$ and $12,$ respectively). The age \times marital status \times time interaction was not significant.

DISCUSSION

Our observations support the statement that a long duration of breastfeeding is associated with low postpartum weight retention. Additional factors associated with postpartum weight retention are age at baseline, marital status, prepregnancy weight, height, and percentage of body fat at baseline.

Previous findings regarding the effect of breastfeeding on postpartum weight retention have been contradictory at best. Few studies, eg, Dewey et al (11), reported any protective effect of breastfeeding practices. Janney et al (13) also reported a pro-

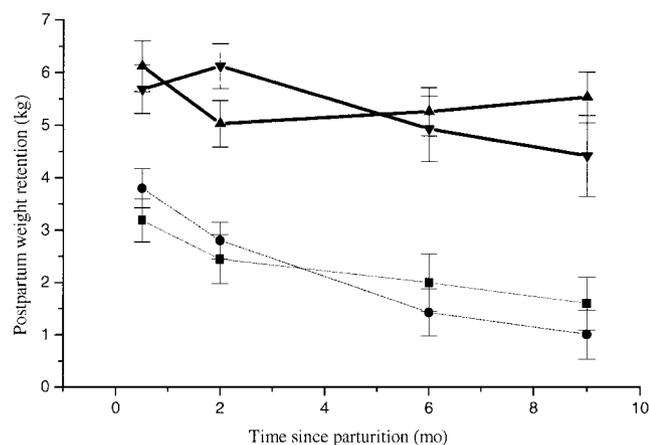


FIGURE 2. Mean (\pm SEM) postpartum weight retention according to breastfeeding duration and percentage of body fat at baseline in Brazilian women aged 18–45 y who lived in the municipality of Rio de Janeiro (1999–2001). ■, Breastfeeding duration below the median and body fat < 30% ($n = 86, 62, 59,$ and 59 at 15 d, 2 mo, 6 mo, and 9 mo, respectively); ●, breastfeeding duration above the median and body fat < 30% ($n = 109, 107, 81,$ and $74,$ respectively); ▲, breastfeeding duration below the median and body fat $\geq 30%$ ($n = 115, 94, 69,$ and $59,$ respectively); ▼, breastfeeding duration above the median and body fat $\geq 30%$ ($n = 95, 88, 78,$ and $68,$ respectively).

protective effect of breastfeeding, although they describe this effect as weak and therefore do not think that any change in policies favoring breastfeeding as a postpartum weight reduction practice is justified. Our findings are consistent with the protective effect reported in Janney et al (13), but the protective effect of breastfeeding was stronger in our study.

The inconsistencies found in various studies on the topic are well summarized by Lederman (20), who lists the main limitations of previous publications, including problems in assessing breastfeeding practices, especially in relation to intensity (21–26), reduced sample size (9, 12), and short duration (10, 23, 27), as well as concerns related to losses to follow-up (10). According to Janney et al (13), another important limitation is the collapsing of repeated weight measurements over time into a single measure of weight change (22, 27–29).

Another study on the same topic (6), which was also conducted in Brazil, addressed the effect of breastfeeding on overall maternal nutritional status but did not focus on postpartum weight retention per se. Using a much longer time perspective (5 y) than ours, the authors also addressed the effect of breastfeeding on the basis of a series of nutritional indexes like BMI, waist-to-hip ratio, arm fat area, and percentage of body fat measured with the use of skinfold thicknesses and impedance. They found that women who breastfed for 6–11.9 mo had lower values for the above-mentioned indexes than did those who breastfed for longer or shorter periods. However, the only one of these differences that was significant was that for percentage of body fat measured with the use of impedance.

Women tend to lose most of the liquid weight components during the first few days after delivery. Therefore, it seems reasonable to assume that postpartum weight retention 9 mo after delivery is attributable mainly to body fat. The use of impedance equations to assess percentage of body fat in postpartum women is not without question. These concerns are more relevant to the immediate postpartum period, especially the first 15 d, than to longer postpartum periods (30), but in the present study, a longer postpartum period was studied.

A particularly interesting finding in our study was the existence of distinct patterns of breastfeeding effects on postpartum weight retention when the effects were stratified by percentage of body fat at baseline. Intermediate longitudinal models showed that breastfeeding duration had no effect on postpartum weight retention in obese women. However, in women with < 30% body fat, this effect was above average. This observation was incorporated into the final statistical model as a second-order interaction effect between these 2 variables because this term was considered both biologically plausible and important for explaining the difference between obese and nonobese women.

To understand the contribution of breastfeeding to postpartum weight retention, we must also consider percentages of body fat at baseline. Predictions based on the final model interaction term showed that among women with 22% body fat, those who breastfed for 180 d will retain 2.2 kg less weight than will those who breastfed for only 30 d. The effect of breastfeeding is also modulated by the content of body fat at baseline, and when only percentage of body fat was varied, differences in postpartum weight retention attributable to breastfeeding were 3.0, 1.7, 1.2, and 0.04 kg in women with 18%, 25%, 28%, and 35% body fat at baseline, respectively. These findings have important public health implications, mainly in relation to policies to encour-

age breastfeeding as a way of minimizing postpartum weight retention.

Several hypotheses could be raised to explain the lack of effect of breastfeeding on postpartum weight retention among obese women, although a more conclusive mechanism is still to be established. One explanation may have to do with differences between obese and lean women in fat weight change during pregnancy (31). According to data from Paxton et al (31), women with a normal prepregnancy BMI had higher values of fat change during pregnancy than did those with a high prepregnancy BMI (ie, those who were obese). If this is true, the effect of breastfeeding might be limited for obese women, whereas postpartum fat loss might be greater in women who gain more fat during pregnancy. Obese women may mobilize less fat, even if their body fat is higher at baseline. We compared gestational weight gain in obese and lean women, and although we observed a higher value among lean women, the differences were not significant. As an alternative hypothesis, obese women may experience greater difficulty in initiating and maintaining breastfeeding than do leaner women (32). In our study there was no difference in the initiation of lactation between the obese and the lean women, although the duration of breastfeeding was slightly but not significantly higher in the lean women.

The final longitudinal regression model also showed the effect of additional covariates on postpartum weight retention. As expected and described in the literature (13, 33), the association with age was positive. Marital status was also associated with postpartum weight retention. Previous exploratory analysis indicated that single women did not retain as much weight as did married women or those with partners. These results contradict those reported by Janney et al (13) and Parker and Abrams (23), who detected less weight retention in married women. The final model fitted to our data also indicated an interaction between marital status and age, which translated as less postpartum weight retention in single women, but only when they were young. The lack of social support for this group of women might explain this finding. On the assumption that marital status is a proxy for social support, it becomes important for health interventions to target single women by fostering better conditions during the postpartum period.

One possible drawback of the present study relates to the source of prepregnancy weight information, which was self-reported by the mothers. In general, women tend to underestimate their weight, which could lead to overestimations of postpartum weight retention. Several studies, including some in Brazil, indicate the good quality of participants' self-reported data (34–37). A second drawback relates to the study participants who were lost to follow-up. Approximately 33% of the women who began the study did not complete the follow-up. Our explorations regarding the pattern of losses to follow-up indicate no departure from a random process, except for age. Although this variable was included in the final model, we believe that we adequately controlled for potential validity problems from this source. Complementary analysis in which data were stratified by age and in which women who were followed to completion were compared with those who were lost to follow-up did not show any differences between the 2 groups of women in mean postpartum weight retention or median duration of breastfeeding at the first visit (18).

In conclusion, we have presented empirical evidence that long durations of breastfeeding are associated with low postpartum

weight retention. This effect is modulated by the content of body fat at baseline in such a way that duration of breastfeeding affects only women with < 30% body fat. That is, the effect is not observed in obese women. Finally, the results presented here provide empirical evidence supporting the implementation of health policies to prevent postpartum weight retention and obesity. 

GK participated in all phases of the study, including conception, design, follow-up, data interpretation, and the writing of the manuscript. MHDAB participated in several phases of the study, including conception, design, data interpretation, and the writing of the manuscript. GV-M participated in several phases of the study, including conception, design, data interpretation, and the writing of the manuscript. JGV participated in several phases of the study, including design, follow-up, data interpretation, and the writing of the manuscript. CJS participated in several phases of the study, including data interpretation and the writing of the manuscript. None of the authors had any real or potential financial or personal conflicts of interest with the financial sponsors of the scientific project.

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