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Breast-Feeding Has a Limited Long-Term Effect on Anthropometry and Body Composition of Brazilian Mothers

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ABSTRACT The effect of lactation on maternal nutrition is controversial. Some studies have shown that breast-feeding reduces maternal weight, whereas some have not. All studies have been restricted to the first 2 y after delivery. We investigated the effect of lactation on maternal nutrition 5 y after delivery. All mothers giving birth in the city of Pelotas, Brazil, in 1993 were interviewed and weighed soon after delivery; information was also obtained on prepregnancy weight. In 1994, information on breast-feeding duration and pattern was collected for a 20% subsample. They were seen again in 1998, and those eligible (nonsmokers, no subsequent pregnancy, last birth weight ≥ 2500 g) underwent measurements for weight, height, waist, hip and arm circumferences, triceps and subscapular skinfolds. The following indices were calculated in 312 women: body mass index, waist/hip ratio, arm fat area, the percentage of body fat assessed through skinfolds, and weight and body mass index change since before conception. The percentage of body fat was also measured through bioimpedance for half of the sample. After adjustment for confounding, all outcomes generally showed a similar pattern, i.e., mothers who breast-fed for 6–11.9 mo had lower measurements than those with shorter or longer durations. However, only the association with bioimpedance was significant ($P < 0.03$), and that for arm fat area tended to be significant ($P = 0.06$). Exclusive or predominant breastfeeding at 4 mo was associated with lower waist circumference ($P = 0.05$) and the percentage of body fat measured through skinfolds ($P = 0.04$). This study suggests that the relationship between breast-feeding and long-term changes in maternal weight is complex and, in this population, not particularly strong. J. Nutr. 131: 78–84, 2001.

KEY WORDS: • *breast-feeding* • *lactation* • *body composition* • *anthropometry* • *mother nutrition*

The increasing prevalence of obesity, particularly in less developed countries, is leading to rising incidences of chronic diseases (1). In Brazil, the percentage of women with a body mass index (BMI) > 30 kg/m^2 increased from 8.2 in 1974 to 13.3% in 1989, an increase of 60% (2). The reasons behind this secular trend include socioeconomic improvement, but may also be affected by a number of other social, environmental and cultural factors including reproductive performance. Changes in parity, birth intervals and breast-feeding duration may have played a role.

It is important to differentiate studies that have addressed weight gain during the whole reproductive cycle (net change in comparison with prepregnancy weight) and postpartum weight retention studies (change in weight after delivery). The literature on the effects of breast-feeding on maternal anthropometry is controversial. Of 14 previous studies on this subject, nine assessed postpartum weight retention and five weight gain during the reproductive cycle. Four showed that breast-feeding significantly reduces weight (3–6) and seven others did not find an association (7–13). Paradoxically, two studies reported weight loss restricted to nonlactating women (14,15) and one showed an increase in the weight of women who breast-fed for >2 mo (16). Part of these differences may be due to inconsistencies in breast-feeding definition, as well as to the variable duration of follow-up. Seven of these studies followed up mothers for >6 mo, and only one did so for 24 mo. Studies of short duration generally did not show a greater effect of breast-feeding on weight loss than those with a longer follow-up. No published studies are available in which women were followed for >2 y.

This study was designed to investigate the effect of breast-feeding on maternal weight and on several other anthropometric indicators of fat tissue, 5 y after delivery. Its goal is to answer the most important question from a Public Health standpoint, namely, does breast-feeding offer protection against obesity in the long term and not just for a few months after delivery?

SUBJECTS AND METHODS

In 1993, 5304 children were born in the five maternity hospitals in Pelotas, southern Brazil (population 300,000). Over 99% of all deliveries in the city in that year took place in one of these hospitals. The city is located in a relatively developed area of Brazil, with a mean annual per capita income of US$2,700, and an infant mortality rate of 22 per 1000 live births.

Hospital interviews were carried out with all mothers. There were only 16 refusals (0.3%). Mothers provided information on prepregnancy weight and were weighed just before delivery and on d 1 postpartum.

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A systematic sample of 1460 children, comprising all low-birthweight infants plus a 20% sample of the remainder, was selected for follow-up at 6 and 12 mo of age. At the latter home visit, 1363 children (93.4%) were examined and their mothers interviewed. In 1997, an attempt was made to locate these 1363 children and 1273 (93.4% again) were traced, with a cumulative rate of losses to follow-up since birth of 12.8%. After excluding twins and children who did not live with their biological mothers, 1236 mothers were available for interview. The last stage of the research consisted of an additional home visit to mothers who satisfied the study's inclusion criteria, i.e., having delivered a baby with a birth weight ≥2500 g (358 exclusions), not smoking (193), and not having been pregnant since the delivery of the index child (308). Of 377 eligible women, 363 were located from June to October 1998 (96.3%), and a further 51 were excluded due to a new pregnancy or for having started smoking, resulting in the final sample of 312 women. For some of the variables, the total numbers available for analysis were smaller because some women refused to participate in specific measurements (particularly subscapular skinfold for which there were 12 refusals).

Data collection was carried out by four University-trained nutritionists. After training in anthropometric methods according to the procedures recommended by Lohman et al. (17), standardization sessions were carried out on 10 women. Intra- and interobserver technical errors of measurements (TEM) were calculated (18). Two months after the initial training, standardization was repeated. All measurements in the field were carried out separately by two anthropometrists. When differences exceeded 2.8 times the mean interobserver TEM, measurements were repeated; if the difference persisted, a third and final set of measurements was carried out. The mean of the values obtained by the two anthropometrists was taken as the final value.

The following anthropometric measures were obtained: weight (using a UNISCALE digital electronic scale with capacity of 150 kg and precision of 0.1 kg; UNICEF, Copenhagen, Denmark); height (using a locally developed portable aluminum height meter, with a precision of 1 mm); arm, waist and hip circumferences (using a nonextensible tape 6 mm in width and 2 m in length; CMS, London, UK); triceps and subscapular skinfolds (Holtain skinfold meter; CMS).

Interobserver technical errors of measurement were as follows: 20 g for weight; 0.18 cm for height; 0.23 cm for arm; 0.56 cm for waist and 0.33 cm for hip circumferences; 0.58 mm for triceps and 0.71 for subscapular skinfolds.

The anthropometric indices used in this analyses were the waist-hip ratio, waist circumference, arm fat index and BMI (kg/m^2). The percentage of body fat was measured through bioimpedance (Tanita Bodyfat Analyzer model TBF-305; Tanita, Tokyo, Japan) and based on Siri's equations derived from skinfold thickness, as adapted by 19.

Change in nutritional status was assessed by comparing the current weight of the women with their reported prepregnancy weight, and calculating changes in weight and BMI. For the BMI, the height measure was obtained in the 1998 survey.

Information on breast-feeding duration were collected at 6 mo (for children weaned before this age) and 12 mo (for the remaining children). Breast-feeding patterns were classified according to Labbok and Krasovec (20).

Several confounding factors were measured. In the hospital questionnaire, information was collected on family income (in minimum wages per month; ordinal variable with five categories); education (in years of schooling; ordinal variable with four categories); age (5-y groups); skin color (white or nonwhite); marital status (single or married); parity (number of children had before the index pregnancy); weight gain during pregnancy based on the difference between recalled prepregnancy weight and that measured in the hospital upon admission (in four groups); prepregnancy BMI (in four groups); prepregnancy weight (<49 kg). In the 1998 interview, information was collected on ownership of household items (a score built from ownership of radio, television or refrigerator, for example; ordinal variable with five categories); employment (not working; paid work at home; working outside the home); physical exercise in the last year (yes or no); number of hours of sleep per night (in quartiles); use of oral contraceptives (yes or no); number of daily meals (discrete); use of alcohol in the last week (yes or no); use of maté tea in the last week (yes or no); special diets (none, weight-reducing, for weight gain); and divorce since the child was born (yes or no). The questionnaire developed by Block et al. (21) was used to estimate dietary intake of fats (in five categories) and fibers (in three categories).

In all phases of data collection, 5% of the interviews were repeated by a supervisor for quality control. Data were double entered using the Epi-Info software (Centers for Disease Control, Atlanta, GA) and checked for range and consistency.

The bivariate analyses included the comparison of the mean values of anthropometric indicators according to breast-feeding duration and pattern, using ANOVA. Multivariate analyses included confounding factors that presented some degree of association ($P < 0.20$) (22) with both the anthropometric outcomes and the breast-feeding variables. The Stata (College Station, TX) package was used for carrying out the backward elimination method for multiple linear regression.

RESULTS

The main characteristics of the sample of 312 women are summarized in **Table 1**. In 1998, very low BMI (<18.5 kg/m^2)

TABLE 1

The percentage of distribution of the sample and means of body mass index (BMI) in 1998 and of weight gain according to socioeconomic and maternal characteristics in 312 mothers that gave birth in the city of Pelotas, Brazil, in 1993[1]

Variable	% sample	BMI, kg/m^2	Weight gain, kg
Monthly family income, *US$*		$P = 0.01$[2]	$P = 0.08$[2]
≤100	10.1	25.0 ± 4.4	3.6 ± 7.5
101–300	24.8	27.2 ± 4.5	6.7 ± 8.6
301–600	32.6	26.2 ± 5.3	5.3 ± 6.3
601–1,000	13.7	26.0 ± 3.9	5.5 ± 6.3
>1,000	18.9	24.4 ± 4.3	3.5 ± 5.7
Maternal schooling, *y*		$P = 0.03$[3]	$P = 0.10$[3]
None	1.9	28.2 ± 5.2	7.6 ± 6.4
1–4	20.9	27.0 ± 4.6	6.2 ± 8.4
5–8	42.4	25.7 ± 4.4	5.1 ± 6.7
≥9	34.7	25.5 ± 5.2	4.5 ± 6.6
Age, *y*		$P = 0.002$[3]	$P = 0.07$[3]
20–29.9	32.4	24.9 ± 4.2	6.4 ± 8.1
30–39.9	49.7	26.1 ± 4.9	4.5 ± 6.7
≥40	17.9	27.3 ± 4.9	4.6 ± 5.6
Parity		$P = 0.001$[3]	$P = 0.06$[2]
1	36.5	25.1 ± 4.3	6.4 ± 8.2
2	26.9	26.0 ± 4.6	4.6 ± 5.8
3	20.5	25.8 ± 5.2	3.5 ± 5.0
≥4	16.0	27.9 ± 5.0	5.3 ± 8.0
Marital status		$P = 0.65$[2]	$P = 0.54$[2]
Unmarried	16.0	25.6 ± 4.4	4.6 ± 8.7
Married	84.0	26.0 ± 4.8	5.3 ± 6.7
Prepregnancy weight, *kg*		$P < 0.001$[3]	$P = 0.31$[3]
<49	8.1	22.0 ± 2.5	6.3 ± 5.1
49–53.9	25.1	23.4 ± 3.0	5.5 ± 7.2
54–60.9	27.0	24.7 ± 3.1	5.0 ± 5.7
≥61	39.7	29.3 ± 5.0	4.8 ± 8.1
Prepregnancy BMI, *kg/m^2*		$P < 0.001$[3]	$P = 0.48$[3]
<18.5	2.3	19.7 ± 1.1	6.4 ± 3.7
18.5–24.9	66.1	24.0 ± 3.0	5.3 ± 6.6
25–29.9	24.3	28.8 ± 3.5	4.6 ± 8.3
≥30	7.2	36.0 ± 4.1	4.9 ± 7.5
Weight gain in pregnancy, *kg*		$P < 0.001$[3]	$P < 0.001$[3]
<7	14.1	28.6 ± 5.8	3.8 ± 7.5
7–9.9	19.3	25.1 ± 4.0	2.5 ± 5.1
10–12.9	26.0	24.8 ± 3.8	4.4 ± 6.3
13–15.9	17.7	25.4 ± 4.4	6.0 ± 6.0
≥16	22.8	26.6 ± 5.3	8.4 ± 8.5

1 Values are means ± SD.
2 *P*-value on the basis of ANOVA.
3 *P*-value of linearity.

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TABLE 2

Anthropometric variables in mothers that gave birth in the city of Pelotas, Brazil, in 1993 at the beginning of pregnancy (1992–93) and in 1998[1]

Variable	1992–93 *n*	Mean	±SD	(range)	1998 *n*	Mean	±SD	(range)
Age, *y*	312	28.42	±6.47	(15.3–46.4)	312	33.50	±6.51	(20.6–52.0)
Weight, *kg*	306	59.75	±10.58	(37.0–113.0)	311	64.78	±12.58	(39.6–122.6)
BMI, *kg/m²*	304	23.88	±4.04	(15.6–41.6)	310	25.92	±4.77	(18.3–43.1)
Height, *cm*					310	158.05	±6.20	(141.8–181.4)
Waist circumference, *cm*					305	82.05	±11.11	(63.4–121.3)
Hip circumference, *cm*					302	100.90	±9.06	(78.0–141.7)
Waist-hip ratio					302	0.81	±0.07	(0.7–1.2)
Mid-upper arm circumference, *cm*	303	30.08	±3.68	(22.8–41.4)	303	30.08	±3.68	(22.8–41.4)
Triceps skinfold, *mm*					303	22.08	±6.76	(9.6–44.4)
Subescapular skinfold, *mm*					300	19.34	±7.71	(7.1–50.5)
Percentage of body fat through impedance	153[2]	38.94	±10.60	(15.0–73.0)	153[2]	38.94	±10.60	(15.0–73.0)
Arm muscle circumference, *cm²*	303	23.14	±2.23	(19.0–31.2)	303	23.14	±2.23	(19.0–31.2)
Arm muscle area, *cm²*					303	36.52	±8.53	(22.1–71.1)
Total arm area, *cm²*					303	73.09	±18.23	(41.2–134.4)
Arm fat area, *cm²*					303	30.06	±11.76	(10.5–75.7)
Arm fat index, %					303	39.97	±7.67	(22.5–56.3)
Body fat through skinfold, %	299	32.15	±4.87	(20.2–43.8)	299	32.15	±4.87	(20.2–43.8)

[1] Values are means ± SD (range).
[2] Measured for only half of the sample.

was observed in <1% of the women, but 17.7% were obese (BMI ≥ 30 kg/m²). All variables included in Table 1, except marital status, were significantly associated with BMI.

The anthropometric variables obtained in 1993 and 1998 are described in **Table 2**. The women gained ~5 kg during this period, and the BMI increased by ~2 kg/m².

The crude means of the anthropometric indices according to breast-feeding duration and pattern are described in **Table 3**. For all but one index, the mean values were higher for women who breast-fed for <1 mo and tended to decrease with longer breast-feeding duration, but increased again in women who breast-fed for >12 mo. The only exception was arm fat index, which did not increase in the last group; this variable showed an association that tended to be significant (test for linear trend: $P = 0.09$) with breast-feeding duration.

Except for the waist-hip ratio, associations with breast-feeding pattern at 4 mo (Table 3) were or tended to be

TABLE 3

Mean anthropometric indices according to breastfeeding duration and pattern in 312 mothers that gave birth in the city of Pelotas, Brazil, in 1993[1]

Breastfeeding	*n*	Mean value in 1998: BMI, *kg/m²*	WHR	WC, *cm*	% FM (Bia)	AFI, %	% FM (ST)	Change between 1992–3 and 1998: BMI gain, *kg/m²*	Weight gain, *kg*
Duration, *mo*	*P*a	0.48	0.17	0.51	0.27	0.55	0.76	0.66	0.74
	*P*b	0.53	0.38	0.93	0.70	0.09	0.51	0.27	0.28
<1	67	26.5	0.81	83.2	40.8	41.0	32.8	3.0	5.8
1–2.9	78	25.9	0.81	81.5	38.9	40.4	31.9	3.0	5.5
3–5.9	47	25.5	0.81	81.1	38.2	39.9	32.0	2.6	5.1
6–11.9	60	25.2	0.80	80.6	35.4	39.1	31.7	2.3	4.1
≥12	60	26.3	0.83	83.6	40.8	39.1	32.3	2.9	5.0
Pattern at 4 mo	*P*a	0.02	0.55	0.06	0.05	0.08	0.03	0.07	0.09
	*P*b	0.04	0.68	0.13	0.06	0.03	0.05	0.04	0.06
Exclusive/predominant	58	24.4	0.80	78.9	34.4	38.6	30.5	1.3	3.3
Partial	98	26.4	0.82	83.2	40.1	39.2	32.6	2.2	5.5
Weaned	153	26.2	0.81	82.3	39.8	41.0	32.4	2.3	5.7

[1] Abbreviations: BMI, body mass index; WHR, waist-hip ratio; WC, waist circumference; FM, fat mass; AFI, arm fat index.
[a] *F*-test for heterogeneity.
[b] *F*-test for linear trend.

TABLE 4

Associations among confounding variables and outcomes in 312 mothers that gave birth in the city of Pelotas, Brazil, in 1993[1]

	BMI, *kg/m²*		WHR		WC, *cm*		%FM (Bia)		BMI gain, *kg/m²*		Weight gain, *kg*		AFI, %		%FM (ST)	
	D[2]	P[3]	D	P	D	P	D	P	D	P	D	P	D	P	D	P
Family income		X*		X		X		X*		X*		X*		X*		X
Schooling	X	X	X	X	X	X	X	X	X	X	X	X			X	X
Social class			X*	X*	X*	X*			X	X	X	X	X*	X*	X*	X*
Age	X*	X	X*	X*	X*	X*	X	X	X*	X	X*	X			X*	X*
Parity	X	X*	X	X	X	X	X*	X*	X	X	X	X*			X	X
Skin color	X*	X*	X	X*	X*	X*	X*	X*	X*	X*	X*	X*			X*	X
Divorced	X	X	X	X	X	X*	X*	X*							X	X
Physical exercise	X*				X*								X*		X*	
Prepregnancy weight	X*				X*		X*						X*		X*	
Weight gain in pregnancy		X*		X		X*		X*		X*		X*				X*
Intake of fat	X	X	X*	X*	X	X*									X*	X*
Intake of fiber		X								X*		X*		X*		X*
Employment	X															
Hours of sleep										X*		X*		X*		

[1] X, variables associated with the anthropometric outcomes and breastfeeding; X*, variables associated with anthropometric outcomes and breastfeeding and $P < 0.20$ in the backward selection. See Table 3 for abbreviations.
[2] Breastfeeding duration.
[3] Breastfeeding pattern.

significant. Values were lower for mothers who breast-fed exclusively or predominantly for ≥4 mo.

The associations between confounding variables, the two breast-feeding measures (pattern and duration) and the eight anthropometric indices are shown in **Table 4**. For each of the 16 combinations of the two breast-feeding variables (exposure) and anthropometric (outcome) variables, all potential confounders associated in a crude analysis with both variables ($P < 0.2$) were selected; these variables are marked with "X" in Table 4. They were then included in a backward elimination multiple linear regression for the anthropometric outcome, and again only those with $P < 0.2$ were retained (X*). Potential confounders that were not associated in the crude analyses with both exposure and outcome were not listed in Table 4 (i.e., marital status; use of oral contraceptives; prepregnancy BMI; number of daily meals; special diets; use of maté tea; use of alcohol).

The results from the crude and multivariate regression analyses including confounding factors are listed in Tables 5–8. The regression coefficients in the body of the tables indicate the change in the anthropometric outcomes associated with breast-feeding duration, relative to mothers who breast-fed for ≥12 mo, and with breast-feeding pattern, relative to mothers who breast-fed exclusively or predominantly at 4 mo.

Both BMI and the percentage of fat mass tended to be

TABLE 5

Linear regression coefficients for body mass index (BMI) and percentage of body fat through impedance according to breastfeeding duration and pattern, crude and adjusted

	BMI, *kg/m²*				%fat mass through impedance			
	Crude		Adjusted		Crude		Adjusted	
Breastfeeding	β (95% CI)[1]	*P*	β (95% CI)	*P*	β (95% CI)	*P*	β (95% CI)	*P*
Duration, *mo*		0.48[a] 0.53[b]		0.43[a] 0.14[b]		0.27[a] 0.70[b]		0.23[a] 0.03[b]
<1	0.19 (−1.49; 1.88)	0.82	1.01 (−0.70; 2.71)	0.25	0.02 (−5.32; 5.35)	1.00	4.80 (−0.51; 10.10)	0.08
1–2.9	−0.41 (−2.02; 1.20)	0.62	0.21 (−1.38; 1.79)	0.80	−1.92 (−6.89; 3.05)	0.45	2.82 (−2.11; 7.74)	0.26
3–5.9	−0.87 (−2.70; 0.96)	0.35	−0.08 (−1.87; 1.72)	0.93	−2.92 (−8.31; 2.47)	0.29	2.28 (−3.08; 7.63)	0.40
6–11.9	−1.19 (−2.90; 0.52)	0.17	−0.63 (−2.30; 1.04)	0.46	−5.40 (−10.79; −0.007)	0.05	−0.87 (−6.18; 4.44)	0.75
≥12	0		0		0		0	
Pattern		0.02[a] 0.04[b]		0.21[a] 0.10[b]		0.05[a] 0.06[b]		0.13[a] 0.05[b]
Exclusive/predominant	0		0		0		0	
Partial	1.99 (0.45; 3.53)	0.01	1.04 (−0.47; 2.55)	0.18	5.63 (0.76; 10.49)	0.02	3.22 (−1.52; 7.96)	0.18
Weaned	1.84 (0.40; 3.27)	0.01	1.27 (−0.14; 2.68)	0.08	5.39 (0.72; 10.06)	0.02	4.63 (0.15; 9.10)	0.04

[1] CI, confidence interval.
[a] *F*-test for heterogeneity.
[b] *F*-test for linear trend.

TABLE 6

Linear regression coefficients for waist-hip ratio (WHR) and waist circumference (WC) according to breastfeeding duration and pattern, crude and adjusted

	WHR				WC, cm			
	Crude		Adjusted		Crude		Adjusted	
Breastfeeding	β (95% CI)[1]	*P*	β (95% CI)	*P*	β (95% CI)	*P*	β (95% CI)	*P*
Duration, *mo*		0.17[a] 0.38[b]		0.13[a] 0.48[b]		0.51[a] 0.93[b]		0.52[a] 0.53[b]
<1	−0.02 (−0.04; 0.007)	0.16	−0.02 (−0.04; 0.008)	0.19	−0.33 (−4.27; 3.62)	0.87	0.95 (−2.98; 4.87)	0.64
1–2.9	−0.02 (−0.05; 0.003)	0.09	−0.02 (−0.04; 0.008)	0.19	−2.05 (−5.87; 1.77)	0.29	−0.43 (−4.22; 3.36)	0.82
3–5.9	−0.03 (−0.06; −0.0002)	0.05	−0.03 (−0.06; −0.005)	0.02	−2.45 (−6.77; 1.87)	0.26	−2.30 (−6.65; 2.06)	0.30
6–11.9	−0.03 (−0.06; −0.004)	0.02	−0.03 (−0.05; −0.003)	0.03	−2.94 (−6.99; 1.11)	0.15	−1.83 (−5.93; 2.27)	0.38
≥12	0		0		0		0	
Pattern		0.55[a] 0.68[b]		0.56[a] 0.39[b]		0.06[a] 0.13[b]		0.14[a] 0.15[b]
Exclusive/predominant	0		0		0		0	
Partial	0.01 (−0.01; 0.04)	0.28	0.01 (−0.01; 0.04)	0.34	4.27 (0.64; 7.90)	0.02	3.54 (−0.21; 7.30)	0.06
Weaned	0.008 (−0.01; 0.03)	0.50	0.01 (−0.01; 0.03)	0.31	3.39 (0.001; 6.78)	0.05	3.15 (−0.30; 6.61)	0.07

[1] CI, confidence interval.
[a] *F*-test for heterogeneity.
[b] *F*-test for linear trend.

lowest for mothers who breast-fed for 6–11.9 mo, and highest for those who breast-fed for <1 mo (**Table 5**). The association with BMI was not significant, but the test for linear trend with the percentage of fat mass was significant ($P = 0.03$). For breast-feeding pattern, there was a borderline linear trend ($P = 0.05$) in the adjusted analysis.

Associations with the other anthropometric outcomes are shown in **Tables 6-8**. In the adjusted analyses, there were no significant associations with breast-feeding duration. For breast-feeding pattern, most crude associations were of borderline significance ($0.05 < P < 0.1$) but became weaker after adjustment. For the percentage of body mass assessed through skinfolds (Table 8) the crude association was significant; after adjustment, however it became borderline ($P = 0.06$). For all outcomes, mothers who breast-fed for <1 mo or >12 mo tended to have the highest values; those breast-feeding for 6–11.9 mo had the lowest. Regarding breast-feeding pattern, those who breast-fed exclusively or predominantly had consistently lower values.

Because the confounding variable weight gain during pregnancy may be considered as a component of the variables total weight gain and BMI gain, the analyses of these two outcomes were repeated without adjusting for pregnancy weight gain; however, the results remained unchanged.

When breast-feeding pattern at 4 mo was recoded as a dichotomous variable (exclusive or predominant vs. partial or weaned) the following adjusted regression coefficients and *P*-levels were observed: weight gain ($\beta = 1.05$ kg; $P = 0.30$),

TABLE 7

Linear regression coefficients for body mass index (BMI) gain (kg/m²) and weight gain (kg) according to breastfeeding duration and pattern, crude and adjusted

	BMI gain, *kg/m²*				Weight gain, *kg*			
	Crude		Adjusted		Crude		Adjusted	
Breastfeeding	β (95% CI)[1]	*P*	β (95% CI)	*P*	β (95% CI)	*P*	β (95% CI)	*P*
Duration, *mo*		0.66[a] 0.26[b]		0.86[a] 0.31[b]		0.73[a] 0.27[b]		0.88[a] 0.31[b]
<1	0.29 (−0.72; 1.31)	0.57	0.35 (−0.67; 1.38)	0.50	0.82 (−1.72; 3.35)	0.53	1.01 (−1.55; 3.56)	0.44
1–2.9	0.23 (−0.73; 1.20)	0.63	0.38 (−0.60; 1.37)	0.44	0.58 (−1.84; 2.89)	0.64	0.94 (−1.53; 3.42)	0.45
3–5.9	−0.04 (−1.14; 1.05)	0.94	0.18 (−0.94; 1.31)	0.75	0.18 (−2.57; 2.93)	0.90	0.76 (−2.07; 3.58)	0.60
6–11.9	−0.41 (−1.43; 0.61)	0.43	−0.08 (−1.13; 0.97)	0.88	−0.83 (−3.39; 1.74)	0.53	0.02 (−2.63; 2.67)	0.99
≥12	0		0		0		0	
Pattern		0.07[a] 0.04[b]		0.42[a] 0.22[b]		0.09[a] 0.06[b]		0.59[a] 0.46[b]
Exclusive/predominant	0		0		0		0	
Partial	0.88 (−0.04; 1.80)	0.06	0.46 (−0.47; 1.39)	0.33	2.14 (−0.18; 4.45)	0.07	1.13 (−1.18; 3.44)	0.34
Weaned	0.99 (0.13; 1.85)	0.02	0.58 (−0.28; 1.45)	0.19	2.34 (0.19; 4.50)	0.03	1.00 (−1.17; 3.18)	0.37

[1] CI, confidence interval.
[a] *F*-test for heterogeneity.
[b] *F*-test for linear trend.

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TABLE 8

Linear regression coefficients for arm fat index (AFI) (%) and percentage of body fat through skinfold thickness according to breastfeeding duration and pattern, crude and adjusted

	AFI, %				%fat mass through skinfold thickness			
	Crude		Adjusted		Crude		Adjusted	
Breastfeeding	β (95% CI)[1]	P	β (95% CI)	P	β (95% CI)	P	β (95% CI)	P
Duration, *mo*		0.55[a] 0.09[b]		0.40[a] 0.06[b]		0.76[a] 0.51[b]		0.48[a] 0.17[b]
<1	1.98 (−0.76; 4.72)	0.16	2.25 (−0.49; 4.98)	0.11	0.56 (−1.20; 2.32)	0.53	1.07 (−0.63; 2.76)	0.22
1–2.9	1.37 (−1.26; 4.01)	0.31	1.81 (−0.82; 4.43)	0.18	−0.34 (−2.03; 1.34)	0.69	0.13 (−1.47; 1.74)	0.87
3–5.9	0.82 (−2.14; 3.79)	0.59	0.29 (−2.68; 3.26)	0.85	−0.24 (−2.14; 1.67)	0.81	−0.29 (−2.13; 1.55)	0.75
6–11.9	0.05 (−2.76; 2.86)	0.97	0.54 (−2.30; 3.38)	0.71	−0.54 (−2.33; 1.25)	0.55	−0.39 (−2.12; 1.34)	0.66
≥12	0		0		0		0	
Pattern		0.08[a] 0.03[b]		0.14[a] 0.11[b]		0.03[a] 0.05[b]		0.12[a] 0.06[b]
Exclusive/predominant	0		0		0		0	
Partial	0.56 (−1.97; 3.09)	0.66	0.37 (−2.19; 2.93)	0.78	2.05 (0.44; 3.67)	0.01	1.30 (−0.29; 2.90)	0.11
Weaned	2.32 (−0.04; 4.69)	0.05	1.98 (−0.43; 4.37)	0.11	1.88 (0.36; 3.39)	0.02	1.54 (0.06; 3.01)	0.04

[1] CI, confidence interval.
[a] *F*-test for heterogeneity.
[b] *F*-test for linear trend.

percentage of body fat through impedance (β = 4.04 percentage points; *P* = 0.059), waist circumference (β = 3.30 cm; *P* = 0.049), waist-hip ratio (β = 0.01; *P* = 0.28), BMI (β = 1.18 kg/m^2; *P* = 0.082), BMI gain (β = 0.53 kg/m^2; *P* = 0.20), percentage of body fat through skinfold thickness (β = 1.45 percentage points; *P* = 0.043) and arm fat index (β = 1.19 percentage points; *P* = 0.31). Therefore, for all variables studied, mothers who breast-fed exclusively or predominantly were thinner than those who breast-fed partially or not at all, but only two differences were significant and two others were borderline (*P* = 0.059 and 0.082).

DISCUSSION

The longitudinal design of this study, including a retrospective and a prospective component, and the collection of data on breast-feeding patterns at different ages of the child allowed a detailed analysis of anthropometric changes after pregnancy. Eight different indices were measured and strict standardization and quality control procedures were used, including duplicate examinations of all women. Losses to follow-up were limited, i.e., 12.8% of the original 1993 cohort could not be examined in 1997, and 3.7% of the mothers located on this occasion could not be found for the subsequent anthropometric evaluation. The mean ± SD pregestational weight of the original cohort women was 58.2 ± 10.5 kg compared with 57.4 ± 10.4 kg for women traced in 1997.

The study was specifically designed to address the issue of breast-feeding and maternal anthropometry. Therefore, mothers who became pregnant again, who smoked, or whose children had a low birthweight were excluded because these three factors are strongly related to both maternal nutrition and lactation. Other factors less strongly associated to both were treated as confounding variables in the analyses. Despite the fact that weight retention (relative to prepregnancy weight) was studied, adjustment for weight gain during pregnancy means that the study can also be interpreted as a postpartum weight change study. It is reassuring that weight gain during pregnancy was not an important confounding factor because, as noted above, such adjustment did not affect the results for BMI or weight gain.

A possible limitation of this study is the use of reported prepregnancy weight. However, several authors have shown a high correlation between reported and measured weight (23,24), including in Brazilian samples (25,26). Also, the average weight gain over time, ~1 kg/y, is consistent with other studies (27,28). The mean BMI based on reported weight was 23.9 kg/m^2 in 1993, whereas in a population-based survey of Pelotas in 1994 (29) that included standardized measurement of women, the projected value for the same mean age was 24.5 kg/m^2.

The mean BMI in 1993 (23.9 kg/m^2) was close to the cut-off of 25.0 kg/m^2 that indicates an increased risk for chronic diseases (1). Similarly, the mean waist circumference (82.1 cm) and waist/hip ratio (0.81) were close to the corresponding cut-offs (1). The percentage of body fat estimates according to impedance (39%) or to arm fat area (40%) were very similar, but that measured through skinfolds was ~7% lower. Relative to NHANES-II, except for triceps skinfold and arm fat area, Pelotas women had larger indices, by up to 20% compared with women with the same mean age (obtained through a regression approach from the original publication (19). Therefore, the study sample does not present evidence of malnutrition; on the contrary, it is closer to overweight.

These findings did not show a linear association between breast-feeding duration and body size and composition 5 y after delivery. For most anthropometric indicators, there was a U-shaped curve in which mothers who breast-fed for 6–11.9 mo had the lowest body size, and those who breast-fed for <1 mo or for ≥12 mo the largest. Most of the adjusted analyses were not significant. The two exceptions were a significant (*P* = 0.03) linear trend for the percentage of body fat measured through impedance and a borderline (*P* = 0.06) linear trend for the arm fat index, both of which decreased with longer breast-feeding duration, but still showed a slight increase after 12 mo.

The initial analyses of breast-feeding pattern at 4 mo showed a significant linear trend (*P* = 0.05) only with impedance. For most variables, women who breast-fed exclusively or predominantly 4 mo after delivery were thinner than those who breast-fed partially or not at all. A regrouping of these categories showed significant results for two variables and borderline results ($P = 0.06$ and 0.08) for two others. These analyses have to be interpreted with caution because the recoding of breast-feeding pattern took place after examining the data.

In summary, although breast-feeding may help reduce weight retention 5 y after delivery in this group, the results are not clear cut, and the most beneficial duration of breast-feeding appears to be 6–11.9 mo.

The possibility of reverse causality cannot be ruled out. Mothers who lost a substantial amount of weight by breast-feeding 6–11.9 mo may have stopped then, whereas those who were still fat continued for >12 mo. Also, prolonged breast-feeding may be associated with a lesser degree of concern about body image and therefore with less effort to reduce weight after delivery. Studies from the United Kingdom (30) showed that women who were concerned about their body shape were less likely to breast-feed. Ethnographic studies are required to investigate this possibility.

During y 1 of breast-feeding, the extra energy expenditure associated with lactation is compensated at least in part by increased food intake, as shown by several studies (5,6,12,14,31,32). We were unable to find any published studies on energy intake for lactating and nonlactating women during y 2 after delivery. If energy intake remains higher and the amount of breast-milk produced decreases, as is normally the case during y 2 of lactation, then breast-feeding for >12 mo could lead to weight gain. This would be compatible with the findings of the present study in which breast-feeding for 6–11.9 mo was associated with the lowest weight retention.

This study suggests that the relationship between breast-feeding and long-term weight retention is complex and, in this population, not particularly strong.

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