CSP CADERNOS DE SAÚDE PÚBLICA
REPORTS IN PUBLIC HEALTH

ARTIGO
ARTICLE

Association of breastfeeding, maternal anthropometry and body composition in women at 30 years of age

Associação entre aleitamento materno, antropometria e composição corporal em mulheres de 30 anos de idade

Asociación entre lactancia materna, antropometría y composición corporal en mujeres con 30 años de edad

Natália Peixoto Lima [1]
Diego G. Bassani [2,3]
Bruna G. C. da Silva [1]
Janaína V. S. Motta [4]
Elma Izze S. Magalhães [1]
Fernando C. Barros [4]
Bernardo L. Horta [1]

doi: 10.1590/0102-311X00122018

Abstract

This study aimed at assessing the association of breastfeeding with maternal body mass index (BMI), waist circumference, fat mass index, fat free mass index, android/gynoid fat ratio and bone mineral density. In 1982, the maternity hospitals in Pelotas, Rio Grande do Sul State, Brazil, were daily visited and all live births were identified and examined. These subjects underwent follow-up for several times. At 30 years of age, the participants were interviewed and examined. Parous women provided information on parity and duration of breastfeeding. Multiple linear regression was used in the multivariate analysis, controlling for genomic ancestry, family income, schooling and smoking at 2004-2005. After controlling for confounding factors, breastfeeding was inversely associated with BMI and fat mass index, whereas breastfeeding per live birth was negatively associated with BMI, waist circumference and fat mass index. Women who had had a child in the last 5 years and had breastfed, showed lower BMI (β = -2.12, 95%CI: -4.2; -0.1), waist circumference (β = -4.46, 95%CI: -8.3; -0.6) and fat mass index (β = -1.79, 95%CI: -3.3; -0.3), whereas no association was observed among those whose last childbirth was > 5 years, but the p-value for the tests of interaction were > 0.05. Our findings suggest that breastfeeding is associated with lower BMI and other adiposity measures, mostly in the first years after delivery. Besides that, it has no negative impact on bone mineral density.

Breast Feeding; Lactation; Anthropometry; Body Composition; Women

Correspondence
N. P. Lima
Programa de Pós-graduação em Epidemiologia, Universidade Federal de Pelotas.
Av. Marechal Deodoro 1160, 3º andar, Pelotas,
RS 96020-220, Brasil.
natyplima@hotmail.com

[1] *Programa de Pós-graduação em Epidemiologia, Universidade Federal de Pelotas, Pelotas, Brasil.*
[2] *Centre for Global Child Health, Hospital for Sick Children, Toronto, Canada.*
[3] *Department of Paediatrics, University of Toronto, Toronto, Canada.*
[4] *Programa de Pós-graduação em Saúde e Comportamento, Universidade Católica de Pelotas, Pelotas, Brasil.*

Introduction

Breastfeeding has clear short-term benefits, decreasing mortality and morbidity from infectious diseases in childhood [1,2]. Additionally, breastfeeding protects against type 2 diabetes and obesity [3], and is positively associated with human capital [4,5]. Beyond the benefits of breastfeeding to those who have been breastfed, studies report that women who breastfed would have lower risk of breast and ovarian cancer, and larger birth spacing [6].

A recently published meta-analysis reported that breastfeeding mothers have lower postpartum weight retention of 380g (95%CI: -640; -110) than those that bottle-fed their child [7]. Furthermore, it has been suggested that breastfeeding would also be associated with the maternal body composition, such as skinfold thickness, fat free mass and fat mass, but most studies failed to observe an association or observed weak associations [8]. During lactation, women have a fetal demand for calcium [9], but the evidence regarding the association between breastfeeding and bone mineral density shows conflicting results and is inconclusive [6,10]. Most studies were conducted in high-income countries, where there is a positive association between socioeconomic status and breastfeeding [11]. Because socioeconomic status is negatively associated with obesity in these settings [12,13,14], the observed associations could be to residual confounding.

This study aimed at evaluating the association between breastfeeding and body mass index (BMI), waist circumference, fat mass index, fat free mass index, android/gynoid fat ratio and bone mineral density in parous women enrolled in the 1982 Pelotas (Brazil) Birth Cohort Study, a setting where duration of breastfeeding is not associated with socioeconomic status [15]. Therefore, this study should not be susceptible to residual confounding by socioeconomic status.

Methods

In 1982, all maternity hospitals in Pelotas, a Southern Brazilian city, were daily visited. The live births whose family lived in the urban area of the city were examined and their mothers interviewed (N = 5,914). These subjects underwent several follow-up visits; further details on the study methodology have been previously published [16,17].

From June 2012 to February 2013, the cohort was invited to a new follow-up study using different strategies to locate cohort members. The subjects (mean age 30.2 years) were invited to the research clinic, where they were interviewed and examined by a trained team [18]. In this study, we included women who had had at least one live birth and were not pregnant at the time of interview.

In the 2012-2013 visit, we collected information on socioeconomic conditions, such as skin color (white; black; brown/indigenous/Asian), years of schooling (0-4; 5-8; 9-11; ≥ 12), and asset index according to the Brazilian Association of Research Companies criterion (A/B; C; D/E). Besides, women were asked about their parity and the duration of breastfeeding of each child. Total duration of breastfeeding was obtained by summing the duration of lactation of all children (in months). Women who breastfed < 1 month was classified as never breastfeeding. Weight was measured using a scale coupled to a BodPod (COSMED, Chicago, USA) equipment with a capacity up to 150kg, and height was measured using a portable stadiometer (aluminum and wood; Pelotas, Brazil). BMI was calculated dividing the weight by the squared height (kg/m^2). Individuals were classified as overweight if BMI was ≥ 25.0kg/m^2. Waist circumference was measured with an inextensible tape with an accuracy of 0.1cm. This measure was collected twice during the same visit; if the difference between the two measures was above 1cm, a third measurement was performed. Total fat mass and free fat mass were evaluated by air displacement plethysmography (BodPod). Fat mass index and fat free mass index were assessed dividing the total fat and fat free mass by the squared height (kg/m^2). Android/gynoid fat ratio was calculated dividing the fat mass in the android region by the gynoid region, which were measured using dual-energy x-ray absorptiometry (DXA). The mineral density of the femoral neck bone was also measured by DXA. Individuals with metal body parts in the femoral neck (plates, pins) and those whose surgical intervention altered the anatomic structure of that segment of the skeleton were excluded from bone mineral density analysis.

Analyses were carried out using Stata, version 14.0 (https://www.stata.com). We used chi-square test and analysis of variance (ANOVA) to compare proportions and means, respectively. Data distribution was assessed, and all outcomes were normally distributed. Multiple linear regression analysis included confounding factors with a p-value < 0.20 for the association with both body composition outcomes and breastfeeding variables. The following potential confounding variables were collected during the 2004-2005 visit: European genomic ancestry (based on approximately 370,000 single nucleotide polymorphisms mutually available for the Pelotas cohort and selected samples of the HapMap and Human Genome Diversity – ADMIXTURE was used to estimate the genomic ancestry of each subject) [19], family income (in Brazilian reais), years of schooling (0-4; 5-8; 9-11; ≥ 12), leisure-time physical activity assessed through the *International Physical Activity Questionnaire* (minutes/week) [20], and self-reported tobacco smoking (reported as "yes" or "no"). Statistical comparisons were based on tests of heterogeneity and linear trend, and the one with the lower p-value was presented. Analysis was also performed stratifying results by time since last birth (< 5; ≥ 5 years) and interaction was tested fitting a linear regression model with an interaction term.

This study was conducted according to the guidelines established in the *Declaration of Helsinki* and all procedures involving human subjects were approved by the Research Ethics Committee of the Faculty of Medicine, Federal University of Pelotas (protocol number: Of. 16/12). Written informed consent was obtained from all subjects.

Results

In 2012-2013, we interviewed 3,701 individuals from the cohort that, added to 325 known deaths, represented a follow-up rate of 68.1%. With respect to women, 1,914 were interviewed and 130 had died, corresponding to 71.1% of the original cohort. Of those interviewed, 1,147 met the eligibility criteria. Information on breastfeeding was available for 1,146 women, while complete data on breastfeeding and at least one of the maternal body composition measures were available for 1,126 women.

Among the subjects included in this analysis, 73.6% were white, 34.4% had completed between 9 and 11 years of schooling, and the mean proportion of European ancestry was 75%. Most women were primiparous (52.6%) and 27.4% had breastfed for at least 24 months. The prevalence of overweight was 59% (Table 1).

With respect to the confounding variables, breastfeeding was higher in women with lower socioeconomic status in 2004-2005 (Table S1 on Supplementary Material: http://cadernos.ensp.fiocruz.br/site/public_site/arquivo/suppl-e00122018_6233.pdf), but no association was observed after taking parity into account (Table S2 on Supplementary Material: http://cadernos.ensp.fiocruz.br/site/public_site/arquivo/suppl-e00122018_6233.pdf). Fat free mass index and bone mineral density were slightly higher in women with lower family income and schooling in 2004-2005, whereas BMI and fat mass index were only associated with income, but these associations did not show a clear pattern (Tables S3 and S4 on Supplementary Material: http://cadernos.ensp.fiocruz.br/site/public_site/arquivo/suppl-e00122018_6233.pdf).

Tables 2 and 3 show the association of breastfeeding with maternal anthropometry and body composition. Even after controlling for possible confounding variables, women who had ever breastfed showed lower BMI (β = -1.57, 95%CI: -2.8; -0.4), waist circumference (β = -3.41, 95%CI: -5.8; -1.0) and fat mass index (β = -1.32, 95%CI: -2.2; -0.4). In addition, the total duration of breastfeeding was inversely associated with BMI and fat mass index. For waist circumference, we observed reduction in all categories of total breastfeeding. For android to gynoid ratio, adjustment for confounding variables slightly decreased the magnitude of the associations and most of the confidence intervals included the reference. Duration of breastfeeding per live birth was negatively associated with BMI, waist circumference and fat mass index. For android to gynoid ratio, the association was not linear, but those who had breastfed for longer periods showed lower values. On the other hand, bone mineral density was not associated with breastfeeding.

Tables 4 and 5 show the analyses stratified by time since last birth. After controlling for confounding variables, women who had had a child in the last 5 years and had ever breastfed, showed lower

Table 1

Characteristics of the studied population (N = 1,126). Pelotas, Rio Grande do Sul State, Brazil, 2012.

	n (%)	Mean (SD)
Skin color		
White	829 (73.6)	-
Black	197 (17.5)	-
Brown/Indigenous/Asian	100 (8.9)	-
Schooling (completed years)		
0-4	92 (8.2)	-
5-8	278 (24.7)	-
9-11	387 (34.4)	-
≥ 12	367 (32.7)	-
Asset index *		
D/E (poorest)	57 (6.5)	-
C	328 (37.3)	-
A/B (richest)	495 (56.2)	-
Proportion of European ancestry	961	0.75 (0.20)
Total duration of breastfeeding (months)		
< 1	122 (10.8)	-
1 to < 6	229 (20.3)	-
6 to < 12	260 (23.1)	-
12 to < 24	207 (18.4)	-
≥ 24	308 (27.4)	-
Parity		
1	593 (52.6)	-
2	334 (29.7)	-
≥ 3	199 (17.7)	-
BMI (kg/m^2)	1,104	27.32 (6.10)
Overweight prevalence	651 (59.0)	-
Waist circumference (cm)	1,126	82.04 (12.08)
Fat mass index (kg/m^2)	1,111	10.75 (4.68)
Free fat mass index (kg/m^2)	1,111	16.53 (1.82)
Android/gynoid fat ratio	1,105	0.46 (0.12)
Femoral neck BMD (g/cm^2)	1,102	1.02 (0.12)

BMD: bone mineral density; SD: standard deviation.

* Brazilian Association of Research Companies criterion.

BMI (β = -2.12, 95%CI: -4.2; -0.1), waist circumference (β = -4.46, 95%CI: -8.3; -0.6) and fat mass index (β = -1.79, 95%CI: -3.3; -0.3), compared to the never breastfeeding group. Among those whose last childbirth was > 5 years, the associations were weaker and the confidence intervals included the reference, but the tests for interaction were not statistically significant (p-value for interaction > 0.05).

Discussion

In this cohort, which has been prospectively submitted to follow-up since birth, breastfeeding was associated with lower fat mass, whereas there was no association with bone mineral density. We observed a trend toward weaker associations among those who had the last birth > 5 years before the interview, but the formal tests for interaction were not statistically significant. Therefore, we cannot exclude that these differences were due to random variation.

Table 2

Maternal anthropometry according to total sum of breastfeeding (N = 1,126). Pelotas, Rio Grande do Sul State, Brazil, 2012.

	n	Regression coefficient (95%CI)			
		BMI (kg/m²)		Waist circumference (cm)	
		Crude	Adjusted *	Crude	Adjusted *
Total duration of breastfeeding		p < 0.01 **	p = 0.01 **	p < 0.01 **	p < 0.01 **
Never	122	Ref.	Ref.	Ref.	Ref.
Ever	1,004	-1.54 (-2.7; -0.4)	-1.57 (-2.8; -0.4)	-3.27 (-5.5; -1.0)	-3.41 (-5.8; -1.0)
Total duration of breastfeeding		p = 0.06 ***	p = 0.03 ***	p = 0.08 **	p = 0.09 **
Never	122	Ref.	Ref.	Ref.	Ref.
1 to < 6	229	-1.38 (-2.7; -0.1)	-1.33 (-2.8; 0.1)	-3.55 (-6.2; -0.9)	-3.55 (-6.4; -0.7)
6 to < 12	260	-1.57 (-2.9; -0.2)	-1.59 (-3.0; -0.2)	-3.40 (-6.0; -0.8)	-3.47 (-6.2; -0.7)
12 to < 24	207	-1.52 (-2.9; -0.1)	-1.47 (-2.9; -0.1)	-2.99 (-5.7; -0.3)	-3.02 (-5.9; -0.1)
≥ 24	308	-1.64 (-2.9; -0.4)	-1.80 (-3.2; -0.4)	-3.14 (-5.7; -0.6)	-3.51 (-6.2; -0.8)
Breastfeeding per live birth		p = 0.02 ***	p = 0.01 ***	p = 0.04 ***	p = 0.04 ***
< 1	133	Ref.	Ref.	Ref.	Ref.
1 to < 3	133	-0.84 (-2.3; 0.7)	-0.97 (-2.6; 0.6)	-2.29 (-5.2; 0.6)	-2.77 (-5.9; 0.3)
3 to < 6	229	-1.86 (-3.2; -0.6)	-1.70 (-3.1; -0.3)	-3.51 (-6.1; -0.9)	-3.37 (-6.1; -0.6)
6 to < 12	278	-1.34 (-2.6; -0.1)	-1.52 (-2.9; -0.2)	-2.63 (-5.1; -0.1)	-2.94 (-5.6; -0.3)
≥ 12	353	-1.62 (-2.8; -0.4)	-1.74 (-3.0; -0.4)	-3.14 (-5.5; -0.7)	-3.39 (-5.9; -0.8)

95%CI: 95% confidence interval; BMI: body mass index; Ref.: reference.

* Adjusted for genomic ancestry and family income, schooling and smoking at 2004-2005 (p < 0.2);

** Test for heterogeneity;

*** Test for linear trend.

With respect to adiposity, the association of breastfeeding with BMI [21,22,23,24,25,26,27] and abdominal adiposity measures [22,24,28,29,30,31,32] have been reported by some studies, whereas others have failed to describe such associations [33,34,35,36]. A systematic review observed that most of the studies reported little or no association between breastfeeding and body composition [8], but the authors did not estimate the pooled effect. In the same token, a lower total fat mass [28,37] was reported among women who breastfed, but others failed to observe such association [32,38,39]. Concerning bone mineral density, two systematic reviews described that the evidence of an association with breastfeeding was not clear because of the high heterogeneity among studies [6,10]. As most studies were conducted in high-income countries, where socioeconomic status is positively associated with breastfeeding [11] and inversely associated with obesity [12,13,14], these results might be due to residual confounding. In our study, when evaluating the duration of breastfeeding per live birth, with the intention of taking parity into account, we observed no association between breastfeeding and socioeconomic variables. Therefore, lower adiposity among women with longer duration of breastfeeding should not be attributed to residual confusion by socioeconomic status.

The *Promotion of Breastfeeding Intervention Trial* (PROBIT) evaluated the effect of breastfeeding on BMI, fat mass index and fat free mass index [40]. In an intention-to-treat analysis, mothers who had been allocated to the breastfeeding promotion group showed, at 11.5 years postpartum, lower BMI (-0.27kg/m², 95%CI: -0.91; 0.37), fat mass index (-0.23kg/m², 95%CI: -0.64; 0.17) and fat free mass index (-0.05kg/m², 95%CI: -0.27; 0.16) than those in the control group, but the confidence intervals included nullity. In that trial, the intervention showed a higher duration of breastfeeding [41], but at six months only 49.8% of mothers in the intervention group were still breastfeeding, as well as 36.1% in the control group. Due to low compliance to study protocol, there is a decrease in the statistical power [42]; therefore, the non-significant association observed in this study should not be considered as an indication that there are no associations.

Concerning the possible mechanisms for the observed association between breastfeeding and maternal adiposity, it has been suggested that lactation may mobilize fat accumulations,

Table 3

Maternal body composition according to total sum of breastfeeding (N = 1,126). Pelotas, Rio Grande do Sul State, Brazil, 2012.

	n	Regression coefficient (95%CI)							
		Fat mass index (kg/m2)		Fat free mass index (kg/m2)		Android/gynoid fat ratio		Femoral neck BMD (g/cm2)	
		Crude	Adjusted *	Crude	Adjusted *	Crude	Adjusted *	Crude	Adjusted *
Total duration of breastfeeding		p < 0.01 **	p < 0.01 **	p = 0.30 **	p = 0.33 **	p = 0.01 **	p = 0.06 **	p = 0.39 **	p = 0.39 **
Never	122	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Ever	1,004	-1.32 (-2.2; -0.4)	-1.32 (-2.2; -0.4)	-0.18 (-0.5; 0.2)	-0.18 (-0.5; 0.2)	-0.029 (-0.05; -0.01)	-0.022 (-0.05; 0.01)	-0.010 (-0.03; 0.01)	-0.011 (-0.04; 0.01)
Total duration of breastfeeding		p < 0.01 ***	p < 0.01 ***	p = 0.34 ***	p = 0.71 ***	p = 0.13 **	p = 0.30 **	p = 0.24 **	p = 0.56 **
Never	122	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
1 to < 6	229	-1.12 (-2.1; -0.1)	-1.05 (-2.1; 0.1)	-0.23 (-0.6; 0.2)	-0.20 (-0.6; 0.2)	-0.033 (-0.06; -0.01)	-0.028 (-0.06; -0.01)	-0.011 (-0.04; 0.02)	-0.007 (-0.04; 0.02)
6 to < 12	260	-1.17 (-2.2; -0.2)	-1.25 (-2.3; -0.2)	-0.28 (-0.7; 0.1)	-0.17 (-0.6; 0.2)	-0.031 (-0.06; -0.01)	-0.026 (-0.05; 0.01)	-0.015 (-0.04; 0.01)	-0.016 (-0.04; 0.01)
12 to < 24	207	-1.31 (-2.4; -0.3)	-1.28 (-2.4; -0.2)	-0.24 (-0.7; 0.2)	-0.22 (-0.7; 0.2)	-0.026 (-0.05; 0.01)	-0.015 (-0.04; 0.01)	-0.021 (-0.05; 0.01)	-0.020 (-0.05; 0.01)
≥ 24	308	-1.62 (-2.6; -0.6)	-1.60 (-2.6; -0.6)	-0.02 (-0.4; 0.4)	-0.14 (-0.5; 0.3)	-0.025 (-0.05; -0.01)	-0.020 (-0.05; 0.01)	0.002 (-0.02; 0.03)	-0.004 (-0.03; 0.02)
Breastfeeding per live birth		p = 0.01 ***	p < 0.01 ***	p = 0.32 **	p = 0.42 ***	p = 0.10 **	p = 0.23 **	p = 0.36 *	p = 0.32 ***
< 1	133	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
1 to < 3	133	-0.79 (-1.9; 0.3)	-0.82 (-2.0; 0.4)	-0.04 (-0.5; 0.4)	-0.07 (-0.5; 0.4)	-0.019 (-0.05; 0.01)	-0.020 (-0.05; 0.01)	-0.001 (-0.03; 0.03)	0.001 (-0.03; 0.03)
3 to < 6	229	-1.42 (-2.4; -0.4)	-1.29 (-2.4; -0.2)	-0.33 (-0.7; 0.1)	-0.25 (-0.7; 0.2)	-0.031 (-0.06; -0.01)	-0.030 (-0.06; -0.01)	-0.024 (-0.05; 0.01)	-0.022 (-0.05; 0.01)
6 to < 12	278	-0.95 (-1.9; 0.1)	-1.15 (-2.2; -0.1)	-0.28 (-0.7; 0.1)	-0.22 (-0.6; 0.2)	-0.031 (-0.06; -0.01)	-0.024 (-0.05; 0.01)	-0.014 (-0.04; 0.01)	-0.018 (-0.05; 0.01)
≥ 12	353	-1.42 (-2.4; -0.5)	-1.48 (-2.5; -0.5)	-0.12 (-0.5; 0.2)	-0.16 (-0.5; 0.2)	-0.021 (-0.04; 0.01)	-0.015 (-0.04; 0.01)	-0.010 (-0.03; 0.01)	-0.012 (-0.04; 0.01)

95%CI: 95% confidence interval; BMD: bone mineral density; Ref.: reference.

* Adjusted for genomic ancestry and family income, schooling and smoking at 2004-2005 (p < 0.2);

** Test for heterogeneity;

*** Test for linear trend.

"resetting" maternal metabolism after pregnancy [43]. Lactation would improve beta-cell function, reducing insulin secretion, and suppress hypothalamic-pituitary-adrenal axis activity through the action of oxytocin and other lactogenic hormones, lowering cortisol levels [44]. Beside this, it has been estimated that exclusive breastfeeding in the first six months of life requires additional energy of approximately 500kcal/day [45]. Therefore, lactation may have an effect on maternal adiposity. Our findings suggest that the benefits of breastfeeding on maternal fatness decrease with time since last birth. This moderation on the effect might be due to the concept of energy balance, i.e. the effect decreases because the energy demand stops after ending the breastfeeding. Similarly with our results, previous studies also reported that the effect of breastfeeding on maternal metabolic outcomes reduces as women age [7,23,24,46,47] and with time since last birth [48,49,50,51].

As strengths of the study, we assessed the association between breastfeeding, maternal anthropometry and body composition using information from a large birth cohort in which all the data was prospectively collected by a trained research team. In 2012-2013, we followed-up 71.1% of women from the original cohort, representing a high follow-up rate. The attrition rate was slightly higher

Table 4

Maternal anthropometry according to total sum of breastfeeding stratified by time since last birth (N = 1,123) *. Pelotas, Rio Grande do Sul State, Brazil, 2012.

	n	Regression coefficient (95%CI)			
		BMI (kg/m2)		Waist circumference (cm)	
		Crude	Adjusted **	Crude	Adjusted **
Total breastfeeding					
Time since last birth (years)		p = 0.50 ***		p = 0.56 ***	
< 5		p = 0.03 #	p = 0.04 #	p = 0.03 #	p = 0.02 #
Never	49	Ref.	Ref.	Ref.	Ref.
Ever	503	-2.19 (-4.1; -0.2)	-2.12 (-4.2; -0.1)	-4.24 (-8.0; -0.5)	-4.46 (-8.3; -0.6)
≥ 5		p = 0.08 #	p = 0.09 #	p = 0.04 #	p = 0.05 #
Never	72	Ref.	Ref.	Ref.	Ref.
Ever	499	-1.24 (-2.6; 0.1)	-1.26 (-2.7; 0.2)	-3.01 (-5.8; -0.2)	-2.95 (-5.9; 0.1)

95%CI: 95% confidence interval; BMI: body mass index; Ref.: reference.
* 3 missing values for time since last birth;
** Adjusted for genomic ancestry and family income, schooling and smoking at 2004-2005 (p < 0.2);
*** p-value for interaction;
# Test for heterogeneity.

Table 5

Maternal body composition according to total sum of breastfeeding stratified by time since last birth (N = 1,123) *. Pelotas, Rio Grande do Sul State, Brazil, 2012.

Total breastfeeding	n	Regression coefficient (95%CI)							
		Fat mass index (kg/m2)		Fat free mass index (kg/m2)		Android/gynoid fat ratio		Femoral neck BMD (g/cm2)	
		Crude	Adjusted **	Crude	Adjusted **	Crude	Adjusted **	Crude	Adjusted **
Time since last birth (years)		p = 0.46 ***		p = 0.72 ***		p = 0.82 ***		p = 0.05 ***	
< 5		p = 0.01 #	p = 0.02 #	p = 0.60 #	p = 0.73 #	p = 0.28 #	p = 0.25 #	p = 0.32 #	p = 0.30 #
Never	49	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Ever	503	-1.88 (-3.3; -0.4)	-1.79 (-3.3; -0.3)	-0.16 (-0.7; 0.4)	-0.11 (-0.7; 0.5)	-0.019 (-0.05; 0.02)	-0.021 (-0.06; 0.01)	0.019 (-0.02; 0.06)	0.020 (-0.02; 0.06)
≥ 5		p = 0.05 #	p = 0.06 #	p = 0.30 #	p = 0.28 #	p < 0.01 #	p = 0.11 #	p = 0.07 #	p = 0.06 #
Never	72	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Ever	499	-1.08 (-2.2; -0.1)	-1.08 (-2.2; 0.1)	-0.22 (-0.6; 0.2)	-0.24 (-0.7; 0.2)	-0.038 (-0.07; -0.01)	-0.025 (-0.06; 0.01)	-0.029 (-0.06; 0.01)	-0.032 (-0.06; 0.01)

95%CI: 95% confidence interval; BMD: bone mineral density; Ref.: reference.
* 3 missing values for time since last birth;
** Adjusted for genomic ancestry and family income, schooling and smoking at 2004-2005 (p < 0.2);
*** p-value for interaction;
# Test for heterogeneity.

among the poorer and the richer women, but was similar for several other baseline characteristics, as genome ancestry and maternal schooling and skin color. Thus, we believe that our results are unlikely to be due to selection bias. However, some limitations should be pointed. In our analysis, we were not able to adjust for some confounding factors, as pre-gestational BMI and weight gain during pregnancy, because information on these variables was not available. Besides, we had no data on patterns and daily frequency of breastfeeding. The latter might have led to a misclassification in the breastfeeding status, but this is a limitation in most of the studies evaluating breastfeeding and maternal health. Further, the breastfeeding measure was collected retrospectively; however, we believe that a possible error in the information on the duration of breastfeeding is independent of the outcomes evaluated, so this classification error would be non-differential. It is also important to mention that, because we tested multiple outcomes, some of the associations could have been statistically significant due to inflation of the type 1 error. However, we observed more significant associations than it would be expected by error. In addition, the outcomes are correlated measures, being unlikely that the results are due to type 1 error.

Because postpartum weight retention is associated with the development of overweight and obesity [52,53], which increases the risk of chronic non-communicable diseases [54,55], the global leading cause of morbidity and mortality [56], ourt study brings further evidence on the beneficial effect of breastfeeding to the mother. These evidence should be taken into consideration when estimating the consequences of breastfeeding on maternal health.

Concluding, our results suggest that recent breastfeeding is associated with lower BMI and other adiposity measures. And, at the same time, it has no negative impact on bone mineral density. These findings suggest that breastfeeding may also have a positive consequence on maternal health, reinforcing, the relevance of interventions aimed at increasing breastfeeding duration.

Contributors

N. P. Lima collaborated in the data collection, conducted the data analysis, interpreted the results and drafted the article. D. G. Bassani, B. G. C. Silva, J. V. S. Motta and E. I. S. Magalhães collaborated in the data analysis, interpretation and drafted the article. F. C. Barros designed the cohort study, collaborated in the data analysis and drafted the article. B. L. Horta participated in the conception, design, analysis, interpretation and discussion of the data.

Additional informations

ORCID: Natália Peixoto Lima (0000-0002-7181-3717); Diego G. Bassani (0000-0001-6704-3820); Bruna G. C. da Silva (0000-0003-2917-7320); Janaína V. S. Motta (0000-0002-3755-845X); Elma Izze S. Magalhães (0000-0001-9909-9861); Fernando C. Barros (0000-0001-5973-1746); Bernardo L. Horta (0000-0001-9843-412X).

Acknowledgments

This article is based on data from the study1982 Pelotas (Brazil) Birth Cohort Study, conducted by the Post-Graduation Program in Epidemiology at Federal University of Pelotas with the collaboration of the Brazilian Public Health Association (ABRASCO), Wellcome Trust, International Development Research Center, World Health Organization, Overseas Development Administration, Brazilian National Program for Centers of Excellence (PRONEX), Brazilian National Research Council (CNPq), and Brazilian Ministry of Health. This study was financed in part by the Graduate Studies Coordinating Board (Capes; Finance Code 001).

References

1. Sankar MJ, Sinha B, Chowdhury R, Bhandari N, Taneja S, Martines J, et al. Optimal breastfeeding practices and infant and child mortality: a systematic review and meta-analysis. Acta Paediatr 2015; 104:3-13.
2. Horta BL, Victora CG. Short-term effects of breastfeeding: a systematic review on the benefits of breastfeeding on diarrhoea and pneumonia mortality. Geneva: World Health Organization; 2013.
3. Horta BL, Loret de Mola C, Victora CG. Long-term consequences of breastfeeding on cholesterol, obesity, systolic blood pressure and type 2 diabetes: a systematic review and meta-analysis. Acta Paediatr 2015; 104:30-7.
4. Horta BL, Loret de Mola C, Victora CG. Breastfeeding and intelligence: a systematic review and meta-analysis. Acta Paediatr 2015; 104:14-9.
5. Victora CG, Horta BL, Loret de Mola C, Quevedo L, Pinheiro RT, Gigante DP, et al. Association between breastfeeding and intelligence, educational attainment, and income at 30 years of age: a prospective birth cohort study from Brazil. Lancet Glob Health 2015; 3:e199-e205.
6. Chowdhury R, Sinha B, Sankar MJ, Taneja S, Bhandari N, Rollins N, et al. Breastfeeding and maternal health outcomes: a systematic review and meta-analysis. Acta Paediatr 2015; 104:96-113.
7. Jiang M, Gao H, Vinyes-Pares G, Yu K, Ma D, Qin X, et al. Association between breastfeeding duration and postpartum weight retention of lactating mothers: a meta-analysis of cohort studies. Clin Nutr 2017; 37:1224-31.

8. Neville CE, McKinley MC, Holmes VA, Spence D, Woodside JV. The relationship between breastfeeding and postpartum weight change-a systematic review and critical evaluation. Int J Obes 2014; 38:577-90.
9. Kovacs CS, Kronenberg HM. Maternal-fetal calcium and bone metabolism during pregnancy, puerperium, and lactation. Endocr Rev 1997; 18:832-72.
10. Gonçalves ACS, Ferreira MF, Hasselmann MH, Faerstein E. O efeito da amamentação na massa óssea de mulheres na pós-menopausa: revisão sistemática de estudos observacionais. Rev Bras Saúde Mater Infant 2015; 15:265-78.
11. Victora CG, Bahl R, Barros AJ, França GV, Horton S, Krasevec J, et al. Breastfeeding in the 21st century: epidemiology, mechanisms, and lifelong effect. Lancet 2016; 387:475-90.
12. McLaren L. Socioeconomic status and obesity. Epidemiol Rev 2007; 29:29-48.
13. Ogden CL, Lamb MM, Carroll MD, Flegal KM. Obesity and socioeconomic status in adults: United States, 2005-2008. NCHS Data Brief 2010 2010; (50):1-8.
14. Newton S, Braithwaite D, Akinyemiju TF. Socio-economic status over the life course and obesity: Systematic review and meta-analysis. PLoS One 2017; 12:e0177151.
15. Victora CG, Matijasevich A, Santos IS, Barros AJ, Horta BL, Barros FC. Breastfeeding and feeding patterns in three birth cohorts in Southern Brazil: trends and differentials. Cad Saúde Pública 2008; 24 Suppl 3:S409-16.
16. Victora CG, Barros FC. Cohort profile: the 1982 Pelotas (Brazil) Birth Cohort Study. Int J Epidemiol 2006; 35:237-42.
17. Barros FC, Victora CG, Horta BL, Gigante DP. Metodologia do estudo da coorte de nascimentos de 1982 a 2004-5, Pelotas, RS. Rev Saúde Pública 2008; 42 Suppl 2:7-15.
18. Horta BL, Gigante DP, Gonçalves H, Motta JS, Loret de Mola C, Oliveira IO, et al. Cohort profile update: the 1982 Pelotas (Brazil) Birth Cohort Study. Int J Epidemiol 2015; 44:441a-441e.
19. Kehdy FS, Gouveia MH, Machado M, Magalhães WC, Horimoto AR, Horta BL, et al. Origin and dynamics of admixture in Brazilians and its effect on the pattern of deleterious mutations. Proc Natl Acad Sci 2015; 112:8696-701.
20. Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, et al. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc 2003; 35:1381-95.
21. Sarkar NR, Taylor R. Weight loss during prolonged lactation in rural Bangladeshi mothers. J Health Popul Nutr 2005; 23:177-83.
22. Gunderson EP, Lewis CE, Wei GS, Whitmer RA, Quesenberry CP, Sidney S. Lactation and changes in maternal metabolic risk factors. Obstet Gynecol 2007; 109:729-38.
23. Cohen SS, Larson CO, Matthews CE, Buchowski MS, Signorello LB, Hargreaves MK, et al. Parity and breastfeeding in relation to obesity among black and white women in the southern community cohort study. J Womens Health (Larchmt) 2009; 18:1323-32.
24. Natland ST, Nilsen TI, Midthjell K, Andersen LF, Forsmo S. Lactation and cardiovascular risk factors in mothers in a population-based study: the HUNT-study. Int Breastfeed J 2012; 7:8.
25. Bobrow KL, Quigley MA, Green J, Reeves GK, Beral V; Million Women Study Collaborators. Persistent effects of women's parity and breastfeeding patterns on their body mass index: results from the Million Women Study. Int J Obes 2013; 37:712-7.
26. Jarlenski MP, Bennett WL, Bleich SN, Barry CL, Stuart EA. Effects of breastfeeding on postpartum weight loss among US women. Prev Med 2014; 69:146-50.
27. Mastroeni MF, Mastroeni SSBS, Czarnobay SA, Ekwaru JP, Loehr SA, Veugelers PJ. Breastfeeding duration for the prevention of excess body weight of mother-child pairs concurrently: a 2-year cohort study. Public Health Nutr 2017; 20:2537-48.
28. Gigante DP, Victora CG, Barros FC. Breastfeeding has a limited long-term effect on anthropometry and body composition of Brazilian mothers. J Nutr 2001; 131:78-84.
29. Ram KT, Bobby P, Hailpern SM, Lo JC, Schocken M, Skurnick J, et al. Duration of lactation is associated with lower prevalence of the metabolic syndrome in midlife – SWAN, the study of women's health across the nation. Am J Obstet Gynecol 2008; 198:268.e1-6.
30. McClure CK, Schwarz EB, Conroy MB, Tepper PG, Janssen I, Sutton-Tyrrell KC. Breastfeeding and subsequent maternal visceral adiposity. Obesity 2011; 19:2205-13.
31. McClure CK, Catov J, Ness R, Schwarz EB. Maternal visceral adiposity by consistency of lactation. Matern Child Health J 2012; 16:316-21.
32. Armenta RF, Kritz-Silverstein D, Wingard D, Laughlin GA, Wooten W, Barrett-Connor E, et al. Association of breastfeeding with postmenopausal visceral adiposity among three racial/ethnic groups. Obesity 2015; 23:475-80.
33. Stuebe AM, Kleinman K, Gillman MW, Rifas-Shiman SL, Gunderson EP, Rich-Edwards J. Duration of lactation and maternal metabolism at 3 years postpartum. J Womens Health 2010; 19:941-50.
34. Tørris C, Thune I, Emaus A, Finstad SE, Bye A, Furberg AS, et al. Duration of lactation, maternal metabolic profile, and body composition in the Norwegian EBBA I-Study. Breastfeed Med 2013; 8:8-15.

35. Groer MW, Jevitt CM, Sahebzamani F, Beckstead JW, Keefe DL. Breastfeeding status and maternal cardiovascular variables across the postpartum. J Womens Health 2013; 22:453-9.
36. Yang L, Li L, Millwood IY, Lewington S, Guo Y, Sherliker P, et al. Adiposity in relation to age at menarche and other reproductive factors among 300,000 Chinese women: findings from China Kadoorie Biobank study. Int J Epidemiol 2017; 46:502-12.
37. Wiklund P, Xu L, Lyytikäinen A, Saltevo J, Wang Q, Völgyi E, et al. Prolonged breast-feeding protects mothers from later-life obesity and related cardio-metabolic disorders. Public Health Nutr 2012; 15:67-74.
38. Kulkarni B, Shatrugna V, Nagalla B, Rani KU. Regional body composition of Indian women from a low-income group and its association with anthropometric indices and reproductive events. Ann Nutr Metab 2010; 56:182-9.
39. Mullaney L, O'Higgins AC, Cawley S, Kennedy R, McCartney D, Turner MJ. Breast-feeding and postpartum maternal weight trajectories. Public Health Nutr 2015; 19:1397-404.
40. Oken E, Patel R, Guthrie LB, Vilchuck K, Bogdanovich N, Sergeichick N, et al. Effects of an intervention to promote breastfeeding on maternal adiposity and blood pressure at 11.5 y postpartum: results from the Promotion of Breastfeeding Intervention Trial, a cluster-randomized controlled trial. Am J Clin Nutr 2013; 98:1048-56.
41. Kramer MS, Chalmers B, Hodnett ED, Sevkovskaya Z, Dzikovich I, Shapiro S, et al. Promotion of Breastfeeding Intervention Trial (PROBIT): a randomized trial in the Republic of Belarus. JAMA 2001; 285:413-20.
42. Jo B. Statistical power in randomized intervention studies with noncompliance. Psychol Methods 2002; 7:178-93.
43. Stuebe AM, Rich-Edwards JW. The reset hypothesis: lactation and maternal metabolism. Am J Perinatol 2009; 26:81-8.
44. Stuebe A. Associations among lactation, maternal carbohydrate metabolism, and cardiovascular health. Clin Obstet Gynecol 2015; 58:827-39.
45. Food and Agriculture Organization. Human energy requirements. Rome: Food and Agriculture Organization; 2001. (Food Nutrition Technical Report Series, 1).
46. Schwarz EB, Ray RM, Stuebe AM, Allison MA, Ness RB, Freiberg MS, et al. Duration of lactation and risk factors for maternal cardiovascular disease. Obstet Gynecol 2009; 113:974-82.
47. Lupton SJ, Chiu CL, Lujic S, Hennessy A, Lind JM. Association between parity and breastfeeding with maternal high blood pressure. Am J Obstet Gynecol 2013; 208:454.e1-454.e7.
48. Stuebe AM, Rich-Edwards JW, Willett WC, Manson JE, Michels KB. Duration of lactation and incidence of type 2 diabetes. JAMA 2005; 294:2601-10.
49. Villegas R, Gao YT, Yang G, Li HL, Elasy T, Zheng W, et al. Duration of breast-feeding and the incidence of type 2 diabetes mellitus in the Shanghai Women's Health Study. Diabetologia 2008; 51:258-66.
50. Jager S, Jacobs S, Kröger J, Fritsche A, Schienkiewitz A, Rubin D, et al. Breast-feeding and maternal risk of type 2 diabetes: a prospective study and meta-analysis. Diabetologia 2014; 57:1355-65.
51. Gunderson EP, Quesenberry Jr. CP, Ning X, Jacobs Jr. DR, Gross M, Goff Jr. DC, et al. Lactation duration and midlife atherosclerosis. Obstet Gynecol 2015; 126:381-90.
52. Linné Y, Dye L, Barkeling B, Rössner S. Long-term weight development in women: a 15-year follow-up of the effects of pregnancy. Obes Res 2004; 12:1166-78.
53. Endres LK, Straub H, McKinney C, Plunkett B, Minkovitz CS, Schetter CD, et al. Postpartum weight retention risk factors and relationship to obesity at 1 year. Obstet Gynecol 2015; 125:144-52.
54. Field AE, Coakley EH, Must A, Spadano JL, Laird N, Dietz WH, et al. Impact of overweight on the risk of developing common chronic diseases during a 10-year period. Arch Intern Med 2001; 161:1581-6.
55. Hubert HB, Feinleib M, McNamara PM, Castelli WP. Obesity as an independent risk factor for cardiovascular disease: a 26-year follow-up of participants in the Framingham Heart Study. Circulation 1983; 67:968-77.
56. World Health Organization. World health statistics 2018: monitoring health for the SDGs, sustainable development goals. Geneva: World Health Organization; 2018.

Resumo

Este estudo teve por objetivo avaliar a associação entre aleitamento materno e índice de massa corporal (IMC), circunferência da cintura, índice de massa gorda, índice de massa magra, razão de gordura andróide/ginóide e densidade mineral óssea maternos. Em 1982, as maternidades de Pelotas, Rio Grande do Sul, Brasil, foram visitadas diariamente e todos os nascidos vivos foram identificados e examinados. Essas pessoas foram seguidas em diversos momentos. Aos 30 anos de idade, as participantes foram entrevistadas e examinadas. As que haviam dado à luz forneceram informação sobre paridade e duração do aleitamento materno. Usamos regressão múltipla linear na análise multivariada, controlando por ancestralidade genômica, renda familiar, escolaridade e tabagismo em 2004-2005. Após controlar por fatores de confundimento, o aleitamento materno estava inversamente associado ao IMC e índice de massa gorda, enquanto o aleitamento materno por nascido vivo estava negativamente associado ao IMC, circunferência da cintura e índice de massa gorda. Mulheres que haviam dado à luz nos últimos 5 anos e que haviam amamentado apresentaram IMC (β = -2,12, IC95%: -4,2; -0,1), circunferência da cintura (β = -4,46, IC95%: -8,3; -0,6) e índice de massa gorda (β = -1,79, IC95%: -3,3; -0,3) mais baixos. Nenhuma associação foi observada entre aquelas cujo último parto havia sido > 5 anos, mas o valor de p dos testes de interação foi > 0,05. Nossos resultados sugerem que o aleitamento materno está associado a valores mais baixos de IMC e de outras medidas de adiposidade, especialmente nos primeiros anos após o parto. Adicionalmente, o aleitamento não tem impacto negativo sobre a densidade mineral óssea.

Aleitamento Materno; Lactação; Antropometria; Composição Corporal; Mulheres

Resumen

El objetivo de este estudio fue evaluar la asociación entre lactancia materna, índice de masa corporal (IMC), perímetro de cintura, índice de grasa corporal, índice de masa libre de grasa, proporción de grasa en hombres/mujeres y densidad mineral ósea. En 1982, se visitaron diariamente hospitales maternales en Pelotas, Rio Grande do Sul, Brasil, y se identificaron y examinaron todos los nacimientos vivos. A estos últimos se les realizó un seguimiento en varias ocasiones. Se entrevistó y examinó a madres con 30 años de edad. Las mujeres con hijos proporcionaron información en paridad y duración de la lactancia. Se usó una regresión múltiple lineal en el análisis multivariado, controlando la ascendencia genómica, los ingresos por hogar, la escolaridad y ser fumador en 2004-2005. Tras controlar los factores de confusión, la lactancia estuvo inversamente asociada con el IMC y el índice de grasa corporal, mientras que la lactancia en nacimientos vivos estuvo negativamente asociada con el IMC, el perímetro de cintura y el índice de masa corporal. Las mujeres que tuvieron un niño en los últimos 5 años, y habían amamantado alguna vez, tuvieron un menor IMC (β = -2,12, IC95%: -4,2; -0,1), perímetro de cintura (β = -4,46, IC95%: -8,3; -0,6) e índice de grasa corporal (β = -1,79, C95%: -3,3; -0,3), mientras que no se observó ninguna asociación entre quienes tuvieron el último parto en > 5 años, pero el valor de p para las pruebas de interacción fue > 0,05. Nuestros resultados plantean que la lactancia materna está asociada con el IMC y otras medidas de adiposidad, la mayor parte durante los primeros años tras el parto. Asimismo, no tuvo impacto negativo en la densidad mineral ósea.

Lactancia Materna; Lactancia; Antropometría; Composición Corporal; Mujeres

Submitted on 27/Jun/2018
Final version resubmitted on 04/Sep/2018
Approved on 10/Sep/2018