Published in final edited form as:
Matern Child Health J. 2012 February ; 16(2): . doi:10.1007/s10995-011-0758-0.

Maternal Visceral Adiposity by Consistency of Lactation

Candace K. McClure,
Department of Epidemiology, University of Pittsburgh, 130 DeSoto Street, 127 N Parran Hall, Pittsburgh, PA 15261, USA

Janet Catov,
Department of Epidemiology and Obstetrics, Gynecology and Reproductive Sciences, University of Pittsburgh, 204 Craft Avenue, Pittsburgh, PA 15213, USA

Roberta Ness, and
The University of Texas School of Public Health, 1200 Herman Pressler, Suite W114, Houston, TX 77030, USA

Eleanor Bimla Schwarz
Department of Epidemiology, Obstetrics, Gynecology, and Reproductive Sciences, University of Pittsburgh, Center for Research on Health Care, 230 McKee Place, Suite 600, Pittsburgh, PA 15213, USA

Candace K. McClure: mcclurec@edc.pitt.edu; Janet Catov: catovjm@upmc.edu; Roberta Ness: Roberta.B.Ness@uth.tmc.edu; Eleanor Bimla Schwarz: Schwarzeb@upmc.edu

Abstract

The purpose of this study was to examine the assocation between lactation and maternal visceral adiposity among US women who were on average 7 years postpartum. This cross-sectional analysis included 89 women who gave birth between 1997 and 2002, who did not have preeclampsia, prepregnancy hypertension or prepregnancy diabetes, and enrolled in The Women and Infant Study of Healthy Hearts (WISH). Computed tomography was used to assess abdominal adiposity. History of lactation was self-reported. Visceral adiposity was greater by 36.96 cm^2 (95% CI: 20.92,53.01) among mothers who never breastfed than mothers who breastfed for ≥3 months after every birth, even after adjustment for age, parity, years since last birth, site, socioeconomic, lifestyle, psychological, and family history variables, early adult BMI, and current BMI. Similarly, in fully adjusted models, mothers who breastfed any of their children for less than 3 months had 20.38 cm^2 (95% CI: 2.70, 38.06) greater visceral adiposity than mothers who consistently breastfed all their children for 3 or more months. This study found that 7 years postpartum visceral fat depots are significantly greater among mothers who lactated for less than 3 months after the birth of each of their children. These results provide a potential physiologic basis for prior findings that women who do not consistently breastfeed are at an increased risk of diabetes, cardiovascular disease, and the metabolic syndrome.

Keywords

Lactation; Maternal health; Obesity; Visceral adiposity; Women

Correspondence to: Candace K. McClure, mcclurec@edc.pitt.edu.

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Introduction

Visceral (or intra-abdominal) fat is more metabolically active than fat depots in other body areas and is linked to a more adverse cardio-metabolic profile [1–5]. Visceral fat is associated with an increased risk of heart disease, diabetes, and the metabolic syndrome [1–5]. During pregnancy, women experience an increase in visceral fat [6]. After pregnancy, mothers who breastfeed their infants expend up to 500 kcal per day producing milk. Lactation may therefore help mobilize fat depots that accumulate during pregnancy. The findings of studies which have compared weight loss among mothers who did or did not breastfeed have been mixed [7, 8]. However, a number of these previous studies of the effect of lactation on maternal weight in later life have not adequately controlled for pre-pregnancy weight, weight gain during pregancy, diet, activity, or other important confounders [9]. Studies examining the effects of lactation on body composition by measuring skin-fold thickness have demonstrated central fat accumulation during pregnancy and mobilization with lactation [10–15], but very few studies have specifically examined the effects of lactation on metabolically-active visceral fat. The purpose of this study was therefore to determine if lactation is associated with visceral adiposity among US women who were on average 7 years postpartum, after controlling for relevant variables.

Materials and Methods

The Women and Infant Study of Healthy Hearts (WISH) is a cohort study of cardiovascular risk factors among women 4–12 years after the delivery of singleton infants who were either small for gestational age (SGA, <10th percentile based on Magee-Womens hospital nomograms which are based on data from over 10,000 births at this hospital), preterm (<37 weeks gestation), or term non-SGA births. This study enrolled women 4–12 years since delivery, because this time frame was determined to be long enough for the post-pregnancy cardiovascular changes of interest to be detectable, while still ensuring that most women would be pre-menopausal. Eligible women were those who gave birth between 1997 and 2002 at Magee-Womens Hospital in Pittsburgh, PA, to a singleton infant, following a pregnancy that was not complicated by preeclampsia, prepregnancy hypertension, or diabetes. Of the 4,908 women identified as eligible via a hospital electronic birth registry, 1,569 (32%) were screened by mail or phone. Of the women screened, 702 (45%) provided informed consent and enrolled (318 term non-SGA births, 196 term SGA births, and 188 preterm births). A subset of WISH women (n = 89) underwent CT for assessment of abdominal adiposity. The 89 women included in these analyses had complete data on lactation, abdominal adiposity, visceral adiposity, subcutaneous adiposity, abdominal circumference, and BMI. The Institutional Review Board of the University of Pittsburgh approved this study. All participants gave written informed consent.

Abdominal Adiposity

Measurements of abdominal visceral fat were performed with CT as previously described. [16, 17] Briefly, a cross-sectional area of abdominal fat was assessed with a single CT scan centered upon the L4–L5. Area of adipose tissue was measured electronically by selecting regions of interest defined by attenuation values of −30 to −190 Hounsfield units. Abdominal circumference was measured at the level of the umbilicus.

Lactation

Lactation history was assessed when women enrolled in WISH by asking women about each of their children, “How old was your child when you stopped nursing?” Women responded with the number of months that they breastfed each child. We considered a woman to have “consistently breastfed” if she breastfed each of her children for ≥3 months, because under the 1993 Family and Medical Leave Act, US working women are granted 12 weeks' unpaid time off to care for a newborn [18]. Women who had breastfed any of their children for <3 months were considered to have "variably breastfed." We compared mothers who had never breastfed any of their infants and mothers who variably breastfed to mothers who consistently breastfed.

Covariates

At the WISH participant visit, data on race/ethnicity (non-Hispanic Black, other); marital status (married or marriage–like, unmarried); maternal education (≤high school, ≥some college); insurance (private, other); annual household income (<$50,000, ≥$50,000); smoking (yes, no); multivitamin use (yes, no); and parity were ascertained. Family history of diabetes, myocardial infarction, and stroke was assessed and included disease in participants' mother, father, brothers, or sisters. Maximum weight gain during pregnancy was assessed by asking women who reported ≥1 live birth, "How much weight did you gain during this pregnancy?" The maximum value across all pregnancies was used. Height and weight were obtained by standard methods, with BMI calculated as weight in kilograms divided by height in meters squared. Optimism and anxiety were measured using validated instruments (the Life Orientation Test and the State Anxiety Score of the Spielberger State-Trait Anxiety Inventory, respectively). Early adult BMI was calculated as weight in kilograms collected by self-report with the question, "Approximately how much did you weigh when you left high school?" divided by current height in meters squared. Physical activity was assessed with the Pfaffenberger Physical Activity Scale and is reported as MET hours/week [19].

Statistical Analysis

We estimated the strength of associations between lactation history and demographic, socioeconomic, and behavioral characteristics using *t*-tests, chi-square tests, and analysis of variance. Total abdominal adiposity, visceral adiposity, subcutaneous adiposity, abdominal circumference and BMI were approximately normally distributed. Multiple linear regression analyses were performed to estimate the associations between lactation history and all measures of adiposity. After initial adjustment for age, parity, birth outcome (term non-small for gestational age (SGA) or preterm), and years since last birth, subsequent models included socioeconomic covariates (race, education, income) and then lifestyle variables (smoking (current vs. no), physical activity, vitamin supplementation, optimism, anxiety), early adult BMI, maximum gestational weight gain, family history (of diabetes, myocardial infarction, or stroke), and current BMI. Covariates that were not normally distributed were natural log-transformed for entry into regression models. Potential issues of collinearity were examined using variance inflation factors with ≥10 indicative of collinearity. Subjects with missing covariate data were dropped from analyses involving that covariate. Analyses were performed with SAS (version 9.2, SAS Institute, Inc, Cary, NC). All tests were two-sided with statistical significance level at 0.05.

Results

The sociodemographic characteristics of the study participants are shown in Table 1. Thirty-three percent of participating mothers reported no history of lactation, 18% reported variable lactation, and 49% reported consistent lactation.

Visceral adiposity was found to be lowest among mothers who consistently lactated. In unadjusted analyses, mothers who never lactated had the greatest visceral adiposity (Table 2). After adjustment for age, parity, site, years since last birth, early adult BMI, socioeconomic, lifestyle, psychological, and family history variables, and current BMI,

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significant differences remained between mothers who never lactated and those who consistently lactated in measures of visceral adiposity. Visceral adiposity among mothers who never lactated was 36.96 cm^2 greater than among mothers who had consistently breastfed (Table 3). Similarly, the ratio of visceral to total abdominal fat was 6% greater among mothers who never lactated than those who consistently lactated after every birth.

Visceral adiposity was also significantly greater among mothers who variably lactated when compared to mothers who consistently lactated. Even after adjustment for age, parity, site, years since last birth, early adult BMI, socioeconomic, lifestyle, psychological, and family history variables, and current BMI, mothers who variably lactated had 20.38 cm^2 greater visceral adiposity than mothers who consistently lactated. Lactation was not associated with subcutaneous abdominal adiposity, total abdominal adiposity, abdominal circumference or BMI.

Discussion

This study found that visceral adiposity was notably higher among mothers who had not lactated after the birth of each of their children, even after controlling for a large number of potential confounders including activity, early adult BMI, and the woman's current BMI. During pregnancy, women are known to accumulate visceral fat [6]. Lactation appears to play an important role in mobilizing this fat. Women who lactated for less than 3 months after each birth exhibited more metabolically active visceral fat than mothers who consistently lactated. These results expand our understanding of the physiologic basis of the findings of prior studies which have indicated that mothers who do not lactate are at increased risk of diabetes [20–22], metabolic syndrome [23], and cardiovascular disease [24, 25].

There is a great degree of variability in previous studies that have assessed the impact of lactation on postpartum fat loss. A number of studies suggest that lactation is associated with postpartum weight loss [26–31], while others fail to report an association [11, 32–36], and yet others report an association between lactation and weight gain [37–40]. During lactation, fat is mobilized from the mother's trunk and thighs [41, 42]; however there is disagreement as to which depot is preferentially utilized [41, 43, 44]. Possible explanations for inconsistencies and disagreements among prior studies include differences in study settings, populations, measurements of weight gain, and adjustment for covariates.

Our findings must be interpreted with the understanding that all observational studies may be subject to residual confounding. As studies have linked obesity and insulin resistance to difficulties with breastfeeding [45], it is possible that a decreased duration of lactation could be a marker for an existing abnormal metabolic profile. Women who breastfeed may also be more likely to participate in other beneficial health behaviors. Prospective studies are therefore needed to further clarify the relationships between visceral adiposity and lactation. Additionally, our results are limited by small sample size and are only generalizable to the hospital from which the data were collected. In addition, the findings of this study may be subject to selection bias as women who agreed to undergo abdominal CT may differ from those who did not. Another limitation of this study is that duration of lactation was self-reported. Recall or reporting bias may have led to some misclassification of women's lactation history. Prior studies have found that women with shorter durations of lactation tend to over-report, while women with longer durations tend to underreport their lactation [46]. Finally, as lactation may affect adiposity through effects on variables that we entered as covariates in some of our models, it is possible that we have over-adjusted some of these results.

In conclusion, this study found that 7 years postpartum, visceral fat depots are significantly greater among mothers who lactated for less than 3 months after the birth of each of their children. These data, and the multiple previous studies that have indicated that lactation confers maternal health benefits [47–49], indicate that supporting mothers' efforts to breastfeed may be an important way to reduce the health burdens of obesity. In addition, the large proportion of mothers in this study who did not breastfeed at all, provides a reminder of the ongoing need for improvements in the antenatal health education mothers receive about the health benefits of breastfeeding. Awareness of women's lactation history may also help clinicians identify women at increased risk of visceral adiposity and related adverse cardiovascular outcomes [1].

Acknowledgments

The WISH Study was funded by NIH grants R01 HL076532. In addition, Dr. Schwarz was funded by the National Institute of Child Health and Development, K23HD051585.

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Table 1

Demographic characteristics of study participants by lactation history (N = 89)

	No lactation N = 29(33%) Mean(SD), median(IQR) or n(%)	Variable lactation N = 16(18%) Mean(SD), median(IQR) or n(%)	Consistent lactation N = 44(49%) Mean(SD), median(IQR) or n(%)	*P*†
Age (years)	37 (6)	38 (7)	42 (6)	<0.01
Parity	3 (1)	3 (1)	2 (1)	0.39
Time since last live birth (years)	6 (3)	6 (3)	7 (2)	0.37
Preterm target pregnancy	15 (52)	7 (44)	18 (41)	0.37
Non-Hispanic Black	15 (52)	2 (13)	6 (14)	<0.01
Current marital status				
Unmarried	12 (41)	3 (19)	7 (16)	
Married/married-like	17 (59)	13 (81)	37 (84)	0.02
Maternal education				
≤HS	14 (48)	4 (25)	7 (16)	
Some college+	15 (52)	12 (75)	37 (84)	<0.01
Current insurance				
Private	21 (72)	14 (88)	42 (95)	
Other	8 (28)	2 (13)	2 (5)	<0.01
Current income				
<$50,000	12 (41)	4 (25)	4 (9.)	
≥$50,000	17 (59)	12 (75)	40 (91)	<0.01
Current smoker	18 (62)	8 (50)	17 (39)	0.049
Physical activity (MET hours/week)	9 (4–18)	8 (5–20)	11 (4–17)	0.85
Family history of diabetes	3 (10)	1 (6)	2 (5)	0.34
Family history of hypertension	20 (69)	8 (57)	29 (69)	0.94
Family history of heart disease	11 (38)	4 (25)	14 (33)	0.68
Family history of stroke	2 (7)	3 (19)	6 (14)	0.42
Vitamin supplement	9 (31)	10 (63)	33 (75)	<0.01
Optimism Scale (LOT)	16 (3)	16 (3)	18 (4)	0.19
Anxiety Scale (SPEIL)	17 (4)	15 (3)	16 (4)	0.66
BMI (kg/m^2)	29 (6)	28 (9)	27 (6)	0.15
High school BMI (kg/m^2)	22 (4)	21 (4)	21 (3)	0.21
Maximum gestational weight gain (kg)	18 (10)	14 (25)	11 (18)	0.14

Consistent lactation = having breastfed all children for >3 months; Variable lactation = having breastfed any child for <3 months *SD* standard deviation, *IQR* interquartile range

† *P* value from chi-square test of trend or analysis of variance test of trend

Table 2

Measures of adiposity, an average of 7 years postpartum, by lactation history

	No lactation N = 29 (32.58%)	**Variable lactation N = 16 (17.98%)**	**Consistent lactation N = 44 (49.44%)**	***P*†**
Total abdominal adiposity (cm^2)	445.54 (215)	432.27 (260)	372.40 (225)	0.18
Visceral adiposity (cm^2)	**106.53 (55)**	**107.76 (72)**	**81.04 (42)**	**0.045**
Subcutaneous adiposity (cm^2)	339.00 (169)	324.51 (192)	274.30 (180)	0.13
Visceral/total abdominal adiposity	0.26 (0.11)	0.25 (0.06)	0.25 (0.10)	0.77
Abdominal circumference (cm)	96.36 (14)	94.43 (17)	89.51 (15)	0.06
BMI	28.62 (6)	28.37 (9)	26.43 (6)	0.18

Consistent lactation = having breastfed all children for >3 months; Variable lactation = having breastfed any child for <3 months

†*P* value from ANOVA test of trend

Presented as mean (SD)

Table 3

Relationships between radiographic and clinical measures of adiposity and lactation

	Lactation	Total abdominal adiposity (cm^2)		Visceral adiposity (cm^2)		Abdominal circumference (cm)		BMI (kg/m^2)	
		Beta	95% CI	Beta		Beta	95% CI	Beta	95% CI
Crude (n = 89)	None	73.14	−35.37, 181.65	**25.49**	**0.58, 50.40**	6.85	−0.34, 14.03	2.39	−0.87, 5.65
	Variable	59.87	−72.57, 192.32	26.73	−3.68, 57.13	4.92	−3.85, 13.69	1.71	−2.26, 5.69
	Consistent	Ref		Ref		Ref		Ref	
Age, parity, years since last live birth, term delivery (n = 89)	None	60.37	−58.10, 178.84	**30.18**	**3.13, 57.23**	4.49	−3.22, 12.21	1.31	−2.17, 4.78
	Variable	51.11	−88.52, 190.73	30.12	−1.76, 62.00	3.22	−5.87, 12.31	0.88	−3.22, 4.97
	Consistent	Ref		Ref		Ref		Ref	
+SES variables[a] (n = 89)	None	46.16	−80.73, 173.06	**35.03**	**6.70, 63.36**	2.62	−5.64, 10.88	0.53	−3.16, 4.21
	Variable	56.07	−86.79, 198.94	29.16	−2.74, 61.05	3.20	−6.10, 12.49	1.07	−3.08, 5.22
	Consistent	Ref		Ref		Ref		Ref	
+Behavioral and psychological variables[b] (n = 88)	None	17.85	−109.03, 144.74	**31.81**	**3.21, 60.41**	1.34	−6.91, 9.59	0.22	−3.46, 3.90
	Variable	33.29	−105.29, 171.88	30.40	−0.84, 61.64	3.17	−5.84, 12.18	1.18	−2.84, 5.20
	Consistent	Ref		Ref		Ref		Ref	
+Early adult BMI, max GWG, family history, and BMI (n = 82)	None	29.59	−17.75, 76.94	**36.96**	**20.92, 53.01**	1.02	−2.81, 4.85		
	Variable	−13.09	−65.26, 39.08	**20.38**	**2.70, 38.06**	−0.56	−4.78, 3.66		
	Consistent	Ref		Ref		Ref			

Consistent lactation = having breastfed all children for >3 months; Variable lactation = having breastfed any child for <3 months CI confidence interval

[a]Additionally adjusted for race, education, and income and insurance payer

[b]Additionally adjusted for smoking, physical activity, vitamin use, optimism, and anxiety