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Lactation and maternal subclinical cardiovascular disease among premenopausal women

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Abstract

Objective—Examine the association between lactation and maternal subclinical cardiovascular disease (sCVD).

Study Design—The Women and Infants Study of Healthy Hearts enrolled 607 mothers who delivered a singleton between 1997 and 2002. In 2007, participating mothers underwent measurements of carotid intima-media thickness, lumen diameter (LD), adventitial diameter (AD), and carotid-femoral pulse wave velocity. Multivariable linear and logistic regression were used to estimate the associations between lactation and sCVD.

Results—Compared with mothers who breastfed for ≥ 3 months after every birth, mothers who never breastfed exhibited a 0.13mm larger LD (95% CI 0.04,0.22) and a 0.12mm larger AD (95% CI 0.02,0.22) in models adjusting for age, parity, birth outcome, sociodemographic variables, health-related behaviors, family history, gestational weight gain, early adult BMI, current BMI, CRP, blood pressure, cholesterol, triglyceride, HDL, glucose and insulin levels.

Conclusions—Mothers who do not breastfeed have vascular characteristics associated with a greater risk of cardiovascular disease.

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Keywords

Adventitial diameter; Lactation; Subclinical Cardiovascular Disease

Introduction

Cardiovascular disease is the leading cause of death for U.S. women. Early physiologic changes that increase future risk of cardiovascular disease can be detected by a variety of methods. For example, carotid ultrasound measures of lumen diameter, adventitial diameter, and intima-media thickness have been identified as informative measures of vascular health¹⁻³ that can be used to identify patients at increased risk of cardiovascular disease.⁴⁻⁶ Similarly, carotid-femoral pulse wave velocity, a measure of arterial stiffness, has been shown to be an independent predictor of cardiovascular events and cardiovascular-related death.^{7,8}

During pregnancy, a mother's body accumulates fat to support fetal growth and in preparation for lactation.⁹ Lactation increases a mother's metabolic expenditure by an estimated 480 kcal/d.¹⁰ We have previously reported that mothers who prematurely discontinue lactation, or do not breastfeed their infants at all, have more visceral fat than mothers who breastfeed all of their infants for at least 3 months.^{11,12} In addition, lactation has been associated with improved insulin requirements,^{13,14} glucose tolerance,¹⁵ lipid metabolism,¹⁶ and C-reactive protein profiles in the postpartum period.¹⁷ Recently, a number of studies have indicated longer-term effects of lactation,^{18,19} including lower risk of midlife metabolic syndrome,²⁰ diabetes,^{18,21} and cardiovascular disease.²²⁻²⁴ The purpose of this study was therefore to examine the associations between lactation and several measures of subclinical cardiovascular disease, including lumen diameter, adventitial diameter, carotid intima-media thickness, and carotid-femoral pulse wave velocity. We hypothesize that before menopause, women who do not breastfeed will exhibit larger lumen and adventitial diameters, thicker carotid intima-media-thickness, and higher carotid-femoral pulse wave velocity than women who breastfed.

Materials and Methods

We conducted a secondary data analysis using data from "The Women and Infant Study of Healthy Hearts" (WISH).²⁵ WISH is a cohort study of cardiovascular risk factors among women 4 to 12 years after the delivery of singleton infants who were preterm, small for gestational age (SGA), or delivered at term with normal growth. The 4 to 12 year time frame was anticipated 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. The Institutional Review Board of the University of Pittsburgh approved this study. 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; these included 318 mothers with term non-small for gestational age (SGA) births, 196 term SGA births (<10th percentile based on Magee-Womens hospital nomograms developed with data from over 10,000 births at this hospital), and 188 preterm (<37 weeks gestation) births. Of the 702 women enrolled, 701 women provided data on lactation. Of these, 39 were missing data on their lumen and adventitial diameters, 42 were missing data on carotid intima-media thickness, and 90 were missing carotid-femoral pulse wave velocity data. We also excluded

women who were postmenopausal (N=38). Thus, the final sample size for this analysis was 569 (81%) (Figure 1).

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. Irrespective of whether a mother chooses to breastfeed, her body initiates lactogenesis after giving birth.²⁶ Because under the 1993 Family and Medical Leave Act US working women are granted only 12 weeks' unpaid time off to care for a newborn,²⁷ many US mothers find it difficult to breastfeed for more than 3 months. Thus, although the American Academy of Pediatrics recommends that women breastfeed for the first year of their infants' life,²⁸ we considered a mother to have successfully breastfed if she breastfed for 3 or more months, and to have prematurely discontinued lactation if she breastfed any of her children for <3 months (or never breastfed at all). Thus, we considered three groups of mothers: those who breastfed each of her children for ≥3 months, those who had breastfed any of their children for <3 months, and those who had never breastfed any of their infants. Mothers' reasons for weaning were not assessed.

Subclinical Cardiovascular Disease

Average carotid artery intima media thickness (IMT) was assessed using an Acuson Sonoline Antares high resolution duplex scanner. Images were digitized from the near and far walls of the distal common carotid artery (one cm proximal to the carotid bulb), far wall of the bulb, and first cm of the far wall of the internal carotid artery (a total of 8 locations). Intima-media thickness measures were performed by electronically tracing the lumen-intima interface and the media-adventitia interface across 1 cm segments in these locations. The mean of all average readings across the 8 locations comprise the average carotid IMT. Common carotid artery adventitial diameters were measured in the same way using the adventitial-medial interface on the near wall and the medial-adventitial interface on the far wall of the common carotid artery. Lumen diameter was measured as the distance between the lumen-intima interfaces. Carotid-femoral pulse wave velocity (cf-PWV) measures were automatically generated using a noninvasive and automated waveform analyzer (Complior SP, Artech Medical, Pantin, France). The Complior records the carotid and femoral pulse waveform using multiarray tonometers. Following 10 minutes of rest in a supine position, sonographers palpate the right femoral artery and the right carotid artery and place the handheld tonometers over these two pulse areas to obtain femoral and carotid pulse waveforms simultaneously. A footpedal is used to start the recording. PWV was calculated by time-phase analysis using volume waveforms of respective arteries (carotid and femoral arteries.) PWV was calculated as (distance between arterial sites) divided by (time between the foot of the respective waveforms). The distance between the sampling sites was measured over the surface of the body with a tape measure (this measure is highly reproducible between sonographers with a correlation of 0.93.) Three distances were measured: 1) from the suprasternal notch to the sampling site on the right common carotid artery; 2) from the suprasternal notch to the inferior edge of the umbilicus; and 3) from the inferior edge of the umbilicus to the sampling site on the right common femoral artery. The final carotid to femoral distance was calculated by subtracting measurement 1 from the sum of 2 and 3.

Three runs of data are used and results were averaged to reduce measurement variability. Replicate readings were performed in the ultrasound laboratory to evaluate reproducibility of the measures. The intraclass correlations were 0.88-0.99 for IMT, 0.91-0.96 for adventitial diameter, and 0.78-0.91 for cf-PWV.

Covariates

Delivery characteristics, including gestational age and infant birth weight, were abstracted from hospital birth records. Birth outcomes were categorized as being preterm, SGA, or term non-SGA infants. Years since last live birth were calculated by subtracting the date of last live birth from date of the WISH participant visit. 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 (number of cigarettes per day); multivitamin use (yes, no) and parity (number of live births) were ascertained. Family history of diabetes, myocardial infarction, and stroke was assessed and included disease in participants' mother, father, brothers, or sisters. Women reported the outcomes of all pregnancies before and following the target pregnancy including gestational age, and were categorized as having one or two or more preterm births. 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. Optimism and anxiety were measured using validated instruments (the Life Orientation Test (LOT) and the State Anxiety Score of the Spielberger State-Trait Anxiety Inventory, respectively). Physical activity was assessed with the Pfaffenberger Physical Activity Scale and is reported as metabolic equivalent tasks (MET) hours/week.²⁹ Height and weight were obtained by standard methods, with BMI calculated as weight in kilograms divided by height in meters squared. 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.

Fasting blood samples were collected and all measurements were completed at the Nutrition Laboratory in the Department of Epidemiology at the University of Pittsburgh, which is Clinical Laboratory Improvement Amendments–certified and participates in the Centers for Disease Control and prevention– National Heart, Lung and Blood Institute Lipid Standardization and College of American Pathologists' Proficiency Programs. Total cholesterol, HDL, and triglycerides were measured using standard enzymatic procedures.³⁰⁻³² LDL was estimated using the Friedewald calculation,³³ glucose was determined by an enzymatic determination, and insulin was measured using a radioimmunoassay procedure developed by Linco Research Inc. CRP was measured using a high-sensitivity turbidimetric method (reagents developed by Carolina Liquid Chemicals, Brea, CA). Blood pressure was evaluated as the mean of three measurements following a 10-minute rest.

Statistical analysis

We used analysis of variance and chi-square tests to examine whether sociodemographic characteristics, cardiovascular risk factors, or measures of subclinical cardiovascular disease varied by lactation history. Due to skewing of the distribution, IMT was dichotomized at and > the 75th percentile (0.60 mm and >0.60 mm, respectively). Multivariable logistic regression was used to estimate the associations between lactation history and intima-media thickness. As lumen diameter, adventitial diameter, and carotid-femoral pulse wave velocity values were normally distributed, multivariable linear regression was used to estimate associations between lactation and lumen and adventitial diameter and lactation and cf-PWV. After initial adjustment for age, parity, birth outcome, gestational age, infant birth weight, additional preterm births (yes/no), years since last birth, socioeconomic covariates (race, education, income) and lifestyle variables (smoking (cigarettes per day), physical activity, vitamin supplementation, optimism, anxiety), early adult BMI, maximum gestational weight gain, and family history (of diabetes, myocardial infarction, or stroke), a subsequent model included current BMI and traditional cardiovascular risk factors (systolic

blood pressure, total cholesterol, high-density lipoprotein, triglycerides, C-reactive protein, glucose, and insulin). 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. Effect modification by birth outcome was assessed using a likelihood ratio test ($\alpha = 0.10$). 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 and lifestyle characteristics of the study participants are shown in Table 1. Forty-four percent of participating mothers reported having breastfed for at least 3 months after every birth; 18% reported having breastfed at least one child <3 months, and 38% had never breastfed. Women who prematurely discontinued lactation were younger (35.60 ± 7 compared with 39.60 ± 6 , $p < 0.01$), closer in time to their last live birth (5.62 ± 3 compared with 6.35 ± 3 , $p < 0.01$), more likely to be non-Hispanic Black (37% compared with 13%, $p < 0.01$), less likely to have college education (54% compared with 85%, $p < 0.01$), less likely to be married or in a married-like relationship (60% compared with 83%, $p < 0.01$), less likely to have private insurance (62% compared with 90%, $p < 0.01$), less likely to have an income of \$50,000 (52% compared with 85%, $p < 0.01$), more likely to smoke (4.4 ± 7 cigarettes per day compared with 2.2 ± 6 cigarettes per day, $p < 0.01$), less likely to take a vitamin (46% compared with 63%, $p < 0.01$), and were less optimistic (LOT score 14.92 ± 4 compared with 16.17 ± 4 , $p < 0.01$) than women who breastfed all of their children for at least three months.

Table 2 shows unadjusted and adjusted cardiovascular characteristics of the participants by lactation history. On average, women who prematurely discontinued lactation exhibited larger lumen and adventitial diameters and greater total cholesterol and triglyceride levels than women who breastfed all of their children for at least three months.

Table 3 shows the associations of lactation with lumen diameter, adventitial diameter, carotid intima-media thickness, and carotid-femoral pulse wave velocity, after adjustment for relevant covariates. After adjusting for age, parity, birth outcome, gestational age, infant birth weight, additional preterm births, years since last live birth, maximum gestational weight gain, early adult BMI, measures of socioeconomic status, and lifestyle and family history variables, mothers who never breastfed exhibited larger lumen diameters (beta=0.11, 95% CI 0.02, 0.20) and larger adventitial diameters (beta=0.11, 95% CI 0.005, 0.21) than mothers who breastfed after each birth for at least 3 months. Interestingly, the relationships between lactation and lumen and adventitial diameters persisted even after adjustment for BMI, as well as traditional cardiovascular risk factors including systolic blood pressure, total cholesterol, HDL, triglycerides, C-reactive protein, glucose, and insulin. In these fully adjusted models, average lumen diameter was 0.13 mm (95% CI 0.04, 0.22) larger and adventitial diameter was 0.12mm (95% CI 0.02, 0.22) larger for mothers who never breastfed compared to mothers who breastfed for at least 3 months after every birth.

In addition, compared with mothers who breastfed for 3 months after every birth, mothers who breastfed any child for <3 months exhibited a 0.11mm larger LD (95% CI 0.002, 0.22) in models adjusting for age, parity, birth outcome, gestational age, infant birth weight, additional preterm birth, sociodemographic variables, health-related behaviors, family history, maximum gestational weight gain, early adult BMI, current BMI, CRP, blood pressure, cholesterol, triglyceride, HDL, glucose and insulin levels.

Birth outcome did not modify the associations between lactation history and any of the outcomes examined.

Comment

This study found that mothers who never breastfed were more likely to exhibit vascular characteristics associated with an increased risk of cardiovascular disease than mothers who breastfed for at least 3 months after every birth. In particular, mothers who had never breastfed exhibited significantly larger lumen and adventitial diameters than mothers who breastfed for at least 3 months after every birth, even after adjusting for multiple socioeconomic, lifestyle, and family history variables. These associations persisted even after additional adjustment for known risk factors for cardiovascular disease, such as body mass index, blood pressure, cholesterol, and glucose. In addition, we observed an association between premature discontinuation of lactation and lumen diameter after adjustment for potential covariates. These findings build upon previous work reporting associations between breastfeeding and improved cardiovascular risk profiles and provide some insight into possible early effects of lactation on a mother's metabolic and vascular health.

Increases in lumen and adventitial diameters begin as early adaptive responses to changes in wall shear stress, and increased carotid artery wall thickness (i.e., arteries enlarge to prevent luminal narrowing). However, larger diameters are ultimately markers of vascular aging, early atherosclerosis, and are associated with cardiovascular risk and adverse cardiovascular events.^{1,2,34-36}

Our results are consistent with those of the Study of Women's Health Across the Nation (SWAN)-Heart Study. In a sample of 297 women 45-58 years of age, in unadjusted models, compared to women who had breastfed all of their children for at least three months, mothers who had not breastfed exhibited larger adventitial diameters and a greater prevalence of coronary artery and aortic calcification.²³ Although the association between lactation and adventitial diameter reported in that study was no longer significant after adjustment for multiple confounders, the association between lactation and aortic calcification remained. Similar to other measures of subclinical cardiovascular disease, calcified atherosclerotic plaques have been prospectively linked to cardiovascular events,^{37,38} including stroke, incident coronary heart disease, and cardiovascular disease mortality. The difference in the significance of the association between lactation and adventitial diameter found in these two studies may be due to the younger age and shorter time since pregnancy of participants in the WISH study.

Previous studies have also demonstrated that lactation is associated with blood pressure,^{39,40} development of diabetes,^{18,19,21} lipid metabolism,²⁰ and maternal adipokine profiles.²⁵ It has been hypothesized that lactation may reduce cardiovascular risk by mobilizing accumulated fat stores, and in particular visceral fat.^{11,12} However, our finding that women who consistently breastfed had smaller lumen and adventitial diameters, even after adjustment for BMI, and other known risk factors for cardiovascular disease points to a need to better understand the other ways lactation may affect maternal health. For example, the long-term effects of prolactin and oxytocin on cardiovascular profiles deserve investigation. Recent studies have found that increased prolactin levels are associated with increased blood pressure⁴¹ and accelerated preclinical atherosclerosis.⁴² In contrast, oxytocin has been associated with lower blood pressure and vascular resistance during stress.⁴³

Our findings must be interpreted with the understanding that all observational studies may be subject to residual confounding. The potential relationships between gestational age,

SGA, and tobacco use with subclinical cardiovascular disease may introduce bias to our findings. In addition, using a complete case approach (i.e., excluding persons with missing data) may also introduce bias to our results. Our results are limited by the relatively small sample of women recruited from a single hospital. Limited power of this study is of particular relevance when interpreting analyses of women who breastfed some but not all of their children for 3 or more months. Although in this study we found no significant effect modification of the relationship between lactation and sCVD by birth outcome, a larger study is needed to truly parse out the associations between breastfeeding and subclinical CVD in preterm, SGA, and term births. Additionally, we did not adjust for multiple comparisons due to small sample sizes within some groups. Duration of lactation was self-reported and recall or reporting bias may have led to some misclassification of women's lactation history. Prior research has found that women with shorter durations of lactation tended to over-report, whereas women with longer durations tended to underreport.⁴⁴ Presuming this misclassification is non-differential with respect to the outcomes examined, it would attenuate estimates of associations between duration of lactation and later health. Nonetheless, we observed significant associations between a history of lactation and lumen diameter, adventitial diameter, and carotid-femoral pulse wave velocity, which are all markers of subclinical cardiovascular disease. Rates of breastfeeding in the US have changed only minimally in the past decade.⁴⁵ Some have hypothesized that women who are able to prolong lactation may lead "less stressful" lives, which may decrease their risk of cardiovascular disease.⁴⁶ Notably, the association between lactation and lumen and adventitial diameter persisted after we controlled for factors associated with lower socioeconomic status (education, income, race, parity, and smoking), as well as measures of optimism and anxiety. However, it remains possible that some aspects of life stress may remain unmeasured and that residual confounding may explain some of this study's findings. Alternatively, as lactation may affect subclinical cardiovascular disease risk 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. Finally, studies have linked obesity and insulin resistance to difficulties with lactation,⁴⁷ suggesting that decreased duration of lactation could be a marker for a pre-existing abnormal metabolic profile. Prospective studies are therefore needed to assess the impact of lactation on women's cardiovascular profiles.

In conclusion, this study found that women who did not breastfeed had larger lumen and adventitial diameters and thus may be at risk for subsequent cardiovascular disease.

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Condensation

Women who do not breastfeed their children have larger lumen and adventitial diameters and thus may be at risk for subsequent cardiovascular disease.

Figure 1.
Flow chart of participant recruitment and data analysis.

Table 1Demographic Characteristics of Study Participants by Lactation History (N=569)^{a,b}

	>3 months lactation after all births N=253(44%)	<3 months lactation after some births N=101(18%)	Never breastfed N=215(38%)	<i>P</i> ^c
Age (yrs)	39.60±6	37.51±7	34.70±7	<0.01
Parity				
1	42(48)	9(10)	37(42)	
2	124(48)	42(16)	96(37)	
3+	87(40)	51(23)	82(37)	0.63
Time since last live birth (yrs)	6.35±3	5.39±3	5.73±3	0.02
Target pregnancy				
SGA	80(47)	27(16)	63(37)	
Preterm	57(44)	22(17)	52(40)	
Term, non-SGA	116(43)	52(19)	100(37)	0.89
Gestational age of target pregnancy	38.06±3	38.09±3	37.99±3	0.79
Infant birth weight (grams)	2832±567	2934±631	2864±590	0.57
Additional preterm births	16(32)	8(16)	26(52)	0.03
Non-Hispanic Black	34(22)	25(16)	93(61)	<0.01
Married or in a married-like relationship	209(53)	72(18)	115(29)	<0.01
Maternal Education HS	38(21)	28(15)	116(64)	<0.01
Current insurance private	227(54)	73(17)	121(29)	<0.01
Current income \$50,000	215(57)	66(17)	99(26)	<0.01
Smoking (Cigarettes/Day)	2.21±6	2.97±6	5.01±8	<0.01
Physical activity (MET hours/week)	12.10±14	15.78±26	13.85±20	0.32
Family History of Diabetes	12(39)	7(23)	12(39)	0.67
Family History of Hypertension	156(48)	62(19)	109(33)	0.01
Family History of Heart Disease	78(50)	32(21)	46(29)	0.02
Family History of Stroke	31(51)	12(20)	18(30)	0.18
Vitamin supplement	160(53)	62(20)	82(27)	<0.01
Optimism Scale (LOT)	16.17±4	15.17±4	14.80±4	<0.01
Anxiety Scale (SPEIL)	17.07±5	17.27±5	17.95±6	0.06
Early adult BMI (kg/m ²)	21.80±10	21.03±3	24.63±18	0.02
Maximum gestational weight gain (lbs)	35.51±15	40.75±16	37.20±18	0.27

^aData are mean±standard deviation, median(interquartile range), or n (%).^bBMI: Body Mass Index; LOT: Life Orientation Test; MET: metabolic equivalent tasks; SPEIL: Spielberger State-Trait Anxiety Inventory^cP value from chi-square test of trend or analysis of variance test of trend.

Table 2

Cardiovascular Characteristics of Mothers by Lactation History^a

	Unadjusted ^b		Adjusted for sociodemographic variables ^c	
	>3 months lactation after all births	<3 months lactation after some births	Never breastfed	p ^d
	N=253(44%)	N=101(18%)	N=215(38%)	
Lumen diameter (mm)	5.39±0.40	5.58±0.47	<0.01	5.54
Adventitial diameter (mm)	6.53±0.44	6.70±0.51	<0.01	6.68
Carotid intima-media thickness (mm)	0.56(0.52,0.61)	0.54(0.50,0.60)	<0.01	0.55
Carotid-femoral pulse wave velocity (mm/s)	7.57±1.57	7.74±1.64	0.24	7.68
BMI (kg/m ²)	25.58±5	27.80±7	<0.01	26.93
SBP (mmHg)	106.25±10	108.37±12	0.04	107.89
DBP (mmHg)	69.51±8	70.16±9	0.40	70.07
CRP	1.32(0.55,3.12)	2.14(0.64,4.43)	0.03	1.70
Total cholesterol (mg/dL)	190.12±36	188.86±41	0.73	194.42
LDL (mg/dL)	111.02±32	111.63±35	0.84	114.53
HDL (mg/dL)	59.81±15	56.18±14	<0.01	58.11
Triglycerides (mg/dL)	83(62,118)	92(63,136)	0.09	97.51
Insulin (international units/mL)	8.60(7.00,12.00)	9.35(7.35,12.35)	<0.01	9.68
Glucose	93.78±9	94.16±12	0.70	94.36

^aBMI: Body Mass Index; CRP: C reactive protein; DBP: diastolic blood pressure; SBP: systolic blood pressure

^bData are mean±standard deviation, median(interquartile range), or n (%).

^cData are presented as mean or geometric mean after adjustment for age, race, education, income, insurance, marital status, current smoking (number of cigarettes per day), and early adult BMI.

^dp value from analysis of variance test of trend.

Table 3
Associations between Lactation and Maternal Measures of Subclinical Cardiovascular Disease

	Lactation	Lumen Diameter (mm)	Adventitial Diameter (mm)	Carotid Intima-Media Thickness 75%tile	Carotid-Femoral Pulse Wave Velocity (mm/s)
		beta(95%CI)	beta(95%CI)	OR(95%CI)	beta(95%CI)
Univariable (n=569)	>3 months lactation after all births	Ref	Ref	Ref	Ref
	<3 months lactation after some births	0.11(0.01,0.22)	0.10(-0.02,0.21)	0.76(0.44,1.31)	-0.06(-0.42,0.30)
Additionally adjusted ^a (n=521)	Never breastfed	0.18(0.10,0.26)	0.17(0.08,0.26)	0.76(0.50,1.17)	0.17(-0.11,0.45)
	>3 months lactation after all births	Ref	Ref	Ref	Ref
Ref	<3 months lactation after some births	0.09(-0.01,0.20)	0.08(-0.03,0.20)	0.62(0.31,1.23)	-0.04(-0.41,0.33)
	Never breastfed	0.11(0.02,0.20)	0.11(0.005,0.21)	0.90(0.50,1.63)	0.20(-0.12,0.51)
Additionally adjusted for traditional CV risk factors ^b (n=510)	>3 months lactation after all births	Ref	Ref	Ref	Ref
	<3 months lactation after some births	0.11(0.002,0.22)	0.10(-0.02,0.21)	0.51(0.24,1.09)	0.02(-0.34,0.37)
Ref	Never breastfed	0.13(0.04,0.22)	0.12(0.02,0.22)	0.79(0.41,1.54)	0.21(-0.10,0.52)

^a Additionally adjusted for age, parity, birth outcome, gestational age, infant birth weight, additional preterm births, years since last live birth, race, education, income, insurance, marital status, current smoking (number of cigarettes per day), physical activity, optimism, anxiety, vitamin use, maximum gestational weight gain (lbs), high school BMI, and family history of diabetes, hypertension, heart disease, and stroke

^b Traditional risk factor variables for cardiovascular disease include BMI, systolic blood pressure, total cholesterol, high-density lipoprotein, triglycerides (natural log), C-reactive protein (natural log), insulin (natural log), and glucose.