

Duration of Lactation and Risk Factors for Maternal Cardiovascular Disease

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OBJECTIVE: To examine dose–response relationships between the cumulative number of months women lactated and postmenopausal risk factors for cardiovascular disease.

METHODS: We examined data from 139,681 postmenopausal women (median age 63 years) who reported at least one live birth on enrolling in the Women’s Health Initiative observational study or controlled trials. Multivariable models were used to control for sociodemographic (age, parity, race, education, income, age at menopause), lifestyle, and family history variables when examining the effect of duration of lactation on risk factors for cardiovascular disease, including obesity (body mass index [BMI] at or above 30), hypertension, self-reported diabetes, hyperlipidemia, and prevalent and incident cardiovascular disease.

RESULTS: Dose-response relationships were seen; in fully adjusted models, women who reported a lifetime history of

more than 12 months of lactation were less likely to have hypertension (odds ratio [OR] 0.88, $P < .001$), diabetes (OR 0.80, $P < .001$), hyperlipidemia (OR 0.81, $P < .001$), or cardiovascular disease (OR 0.91, $P = .008$) than women who never breast-fed, but they were not less likely to be obese. In models adjusted for all above variables and BMI, similar relationships were seen. Using multivariate adjusted prevalence ratios from generalized linear models, we estimate that among parous women who did not breast-feed compared with those who breast-fed for more than 12 months, 42.1% versus 38.6% would have hypertension, 5.3% versus 4.3% would have diabetes, 14.8% versus 12.3% would have hyperlipidemia, and 9.9% versus 9.1% would have developed cardiovascular disease when postmenopausal. Over an average of 7.9 years of postmenopausal participation in the Women’s Health Initiative, women with a single live birth who breast-fed for 7–12 months were significantly less likely to develop cardiovascular disease (hazard ratio 0.72, 95% confidence interval 0.53–0.97) than women who never breast-fed.

CONCLUSION: Among postmenopausal women, increased duration of lactation was associated with a lower prevalence of hypertension, diabetes, hyperlipidemia, and cardiovascular disease.

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LEVEL OF EVIDENCE: II

Cardiovascular disease is the leading cause of death for women in developed nations. As such, it is important to identify behaviors that modify women’s risk of cardiovascular disease. Diet and exercise are widely known to affect cardiovascular disease, but less is known about the effect a woman’s decision to breast-feed her children may have on her future risk of cardiovascular disease. Although breast-feeding is widely acknowledged to benefit infant health, in 2004 only 11% of U.S. mothers exclusively breast-fed their infants for the first 6 months of the infant’s life.¹

Lactation increases a mother’s metabolic expenditure by an estimated 480 kcal/d²; lactating mothers

See related editorial on page 972.

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lose more weight in the postpartum period than do women who do not breast-feed.³ Active lactation has been shown to improve glucose tolerance,⁴ lipid metabolism,⁵ and C-reactive protein.⁶ Recently, a number of studies have indicated longer range effects of lactation.^{7,8}

Whether lactation actually decreases risk of cardiovascular disease and whether the benefits of lactation persist after menopause is unclear. The goal of this study was, therefore, to examine the effect of lactation on subsequent risk of obesity, hypertension, diabetes, hyperlipidemia, and cardiovascular disease among 139,681 postmenopausal women.

MATERIALS AND METHODS

The Women's Health Initiative (WHI) began in 1994 and consisted of a set of clinical trials and an observational study focused on strategies for preventing chronic disease in postmenopausal women. Detailed descriptions of the design of the WHI and the baseline characteristics of the participants have been published previously.^{9,10} Briefly, the WHI involved 161,808 generally healthy postmenopausal women who were 50 to 79 years of age on enrollment. Methods regarding data collection, data management, and assurance of the quality of the data have been published previously.^{11,12} At a baseline clinic visit, each woman completed questionnaires regarding medical, reproductive, and family history, medication use, and lifestyle. Participants then were sent annual medical update forms to report any hospitalizations. The occurrence of a wide variety of other outcomes, including myocardial infarction, also was assessed with annual questionnaires. Confirmation of hospitalization and other reported outcomes was based on medical record review.¹² All deaths caused by coronary disease were adjudicated using death certificates, available medical records, and descriptions of events. As of September 2005, for participants in the WHI observational study and controlled trials, the median duration of follow-up was 7.9 years. At that time, 4.7% and 4.6% of participants had withdrawn or were alive but lost to follow-up from the observational study and controlled trials, respectively.

Lactation history was assessed when women enrolled in the WHI by asking women who reported at least one live birth, "Did you breast-feed or nurse any children for at least one month?" Women who responded yes then were asked, "Thinking about all the children you breast-fed, how many months total did you breast-feed? (your best guess)." These responses

then were recorded as a categorical variable (none, 1–6 months, 7–12 months, 13–23 months, and 24 months or more) indicating cumulative lifetime duration of lactation. Age at last lactation also was ascertained as a categorical variable (younger than 20, 20–24, 25–29, 30–34, 35–39, 40–44, and 45 years or older). To estimate years between last lactation and WHI enrollment, we assigned each woman a mid-interval value as the age she last lactated and subtracted this value from age at WHI enrollment.

In this study, we examined five cardiovascular risk factors identified at the baseline clinic visit: obesity, hypertension, diabetes, hyperlipidemia, and a history of cardiovascular disease before enrolling in the WHI. In addition, we examined incident cardiovascular disease over the 7.9 years WHI participants were followed. All incident cardiovascular disease (coronary heart disease, stroke, congestive heart failure, angina, peripheral vascular disease, carotid artery disease, and coronary revascularization) was validated by physician adjudication using standardized protocols.¹²

Obesity was measured using body mass index (BMI) calculated from height and weight collected by study staff at baseline clinic visits. When considering obesity as a dependent variable, we compared women whose BMIs were 30 or higher with those whose BMIs were less than 30. Women with hypertension were identified as those with a self-reported history of treated hypertension or blood pressure measurements meeting criteria for hypertension.¹³ Women with diabetes or hyperlipidemia were identified by self-reported history of need to use a medication to control "sugar diabetes" or "cholesterol." Medication use was validated on enrollment by nurse examination of medication bottles, which participants were instructed to bring to the enrollment visit. For a subset of women, serum lipid levels were drawn and used to confirm self-reported hyperlipidemia. Women with cardiovascular disease on enrollment were identified by a self-reported history of myocardial infarction, angina, congestive heart failure, peripheral arterial disease, revascularization, carotid angioplasty, carotid endarterectomy, or stroke.

On enrollment, dietary information was collected using a 120-item semiquantitative food frequency questionnaire developed for the WHI. When adjusting for diet in these analyses, we considered energy, cholesterol, fat, fiber, and sodium intakes. Data on use of aspirin, multivitamins, tobacco, and postmenopausal hormone therapy also was reported on enrollment. Physical activity also was reported on enroll-



ment questionnaires that elicited total hours per week engaged in a specified list of moderate to vigorous activities. The reproducibility and validity of WHI measures of physical activity have been described previously.¹⁴ Observational study participants also reported their weight at age 18 and at birth and whether they had been breast-fed themselves.

We excluded women who were nulliparous ($n=19,202$) or for whom information on parity ($n=973$) or duration of lactation ($n=1,705$) was missing. We also excluded 247 parous women who reported only stillbirths.

For each of the five outcomes assessed at baseline (obesity, hypertension, hyperlipidemia, diabetes, and a history of cardiovascular disease), we first examined unadjusted relationships between any history of lactation and then duration of lactation and the prevalence of cardiovascular risk factors. We then constructed multivariable logistic regression models to examine the relationship between duration of lactation and each of these outcomes while adjusting for sociodemographic variables (age, parity, race/ethnicity, income, education). Next we examined models additionally adjusted for lifestyle variables (diet, physical activity, smoking, and use of postmenopausal hormone therapy, aspirin, or a multivitamin) and family history (of diabetes, myocardial infarction, and stroke).

Because obesity has been linked closely to cardiovascular disease,¹⁵ for all outcomes other than obesity, we further examined models adjusted for all of the above variables and BMI (measured using categories of BMI less than 25, 25 to less than 30, and 30 or higher). Because weight at age 18, birth weight, and whether a woman was breast-fed herself in infancy¹⁵ also may affect subsequent risk of cardiovascular disease, we examined the relationship between duration of lactation and each of these outcomes when these additional self-reported variables were added to models.

We used Cox proportional hazard models to compute hazard ratios for incident cardiovascular disease, adjusting for covariates as described above. The proportional hazards assumption was met by testing for interaction of lactation duration with the time variable. In addition, we performed an analysis in which we examined the subgroup of 126,020 women who reported no cardiovascular disease on enrolling in the WHI.

Because prior work has shown that the benefits of lactation may decrease with time since lactation⁷ and that there is significant racial variation in rates of breast-feeding,¹⁶ we examined our data stratified by age, age at last lactation, parity, and race.

Finally, we used multivariate generalized linear models to estimate adjusted prevalence ratios. For all models, to test for dose-response relationships, we examined linear trends across categories of increasing duration of lactation by modeling the categorical breast-feeding duration variable as a continuous variable. All analyses were conducted using SAS 9.1 (SAS Institute, Cary, NC). Participants with missing covariate data were dropped from analyses involving that covariate. The institutional review board of the University of Pittsburgh approved this study.

RESULTS

This analysis included 139,681 women with at least one live birth and no missing information on lactation (59,769 women who participated in the WHI controlled trials and 79,912 who participated in the WHI observational study). Sociodemographic characteristics of the postmenopausal study participants are shown in Table 1. The majority of patients (58%) reported some history of lactation, but only 6% had a cumulative history of lactation greater than 24 months. Few women reported 12 or more months of lactation per live birth. On average, 35 years had passed since women had lactated when they enrolled in the WHI.

On enrollment in the WHI, 30% of women were obese (BMI 30 or higher). In age-adjusted analyses, we found parous women were more likely to be obese or hypertensive than nulliparous women. However, parous women who had lactated were less likely to be obese or have hypertension than parous women who had not lactated. In similar age-adjusted models, we found the prevalence of diabetes and hyperlipidemia was not significantly different among nulliparous or parous women who had lactated. However, parous women who had not lactated were more likely to have diabetes or hyperlipidemia than were parous women who had lactated.

Table 2 shows the relationship between duration of lactation and obesity among parous women. Increasing duration of lactation was associated with a lower prevalence of obesity in the univariable model and in the model adjusted for sociodemographic variables. After additional adjustment for lifestyle and family history variables, however, we did not find a significant relationship between 6 or fewer or 24 or more months of lactation and prevalence of postmenopausal obesity; with 7–23 months of lactation, there was a trend toward less obesity ($P=.07$).

Increasing duration of lactation was associated with a reduced prevalence of cardiovascular risk factors, including hypertension, diabetes, and hyper-



Table 1. Characteristics of Women Enrolling in the Women's Health Initiative Observational Study or Controlled Trials Who Reported One or More Live Births (N=139,681)

	No Lactation (n=58,526)	Any Lactation (n=81,155)	1–6 Mo (n=41,151)	7–12 Mo (n=17,639)	13–23 Mo (n=13,604)	24+ Mo (n=8,761)
Age	62.9 (7.0)	63.6 (7.2)	63.8 (7.2)	63.3 (7.4)	63.4 (7.2)	63.6 (7.3)
Age at menopause	47.9 (6.5)	48.5 (6.3)	48.1 (6.5)	48.5 (6.2)	49.0 (5.9)	49.3 (6.0)
Live births	2.8 (1.4)	3.3 (1.6)	3.0 (1.5)	3.2 (1.4)	3.5 (1.4)	4.6 (1.7)
Race						
Native American	0.4	0.5	0.5	0.4	0.4	0.8
Asian/Pacific Islander	1.7	3.1	3.1	3.3	2.6	3.5
African American	9.3	8.3	9.1	8.7	6.0	7.4
Hispanic/Latina	3.6	4.3	4.2	4.2	3.5	6.0
White	83.7	82.4	81.6	82.1	86.1	80.9
Other	1.3	1.4	1.4	1.3	1.4	1.5
Education						
Less than high school	5.3	5.7	5.6	5.7	4.6	8.4
High school/GED	22.1	15.2	17.4	14.0	12.1	12.8
Vocational/training school; some college; associates degree	41.1	37.7	40.7	35.4	34.4	33.0
College graduate	31.5	41.4	36.4	44.9	48.9	45.9
Income (\$)						
Less than 34,999	40.9	41.2	43.0	38.9	37.3	43.5
35,000–74,999	41.5	39.4	39.4	39.7	39.9	37.5
75,000+	17.7	9.5	17.7	21.4	22.7	9.0
Smoking						
Never smoked	47.7	53.5	50.3	54.1	56.4	62.5
Past smoker	44.5	40.3	42.4	40.1	38.6	33.6
Current smoker	7.9	6.2	7.3	5.9	5.0	3.9
Postmenopausal hormone therapy						
Past user	16.0	16.2	16.8	15.8	15.5	14.7
Current user	39.7	40.9	41.3	41.7	41.5	36.1
Aspirin	19.9	20.6	20.7	20.1	21.0	20.6
Multivitamin	38.1	39.7	39.6	40.0	40.4	38.1
Family history of						
Diabetes	35.4	33.0	34.0	32.3	31.0	32.6
Stroke	37.6	38.7	38.9	38.5	38.4	38.5
Myocardial infarction	53.5	51.7	52.7	50.3	51.4	50.4
Physical activity						
MET h/wk	12.0 (13.5)	12.8 (13.8)	12.3 (13.6)	13.1 (13.8)	13.5 (14.1)	13.1 (14.4)
Dietary intake						
Energy, kcal	1,616 (647)	1,663 (641)	1,639 (642)	1,660 (623)	1,704 (641)	1,718 (649)
Fiber (g)	15.4 (6.6)	16.6 (6.9)	16.0 (6.7)	16.6 (6.9)	17.3 (7.1)	17.6 (7.4)
Total fat (g)	61.1 (33.2)	61.6 (32.5)	61.3 (32.8)	61.0 (31.7)	62.4 (32.5)	63.2 (32.7)
Cholesterol (g)	219 (130)	222 (131)	221	220 (130)	224 (129)	228 (133)
Sodium (mg)	2,702 (1,153)	2,784 (1,160)	2,741 (1,157)	2,779 (1,146)	2,852 (1,159)	2,886 (1,191)
Body mass index	28.2 (6.0)	27.9 (5.8)	28.0 (5.9)	27.8 (5.8)	27.7 (5.7)	28.2 (5.9)

GED, general equivalency diploma; MET, metabolic equivalent.
Data are mean (standard deviation) or % unless otherwise specified.

lipidemia, even after adjustment for sociodemographic variables, lifestyle variables, family history, and BMI category ($P<.01$ for all tests for trend, Table 3). Similarly, increasing duration of lactation was associated with a lower prevalence of cardiovascular disease before enrolling in the WHI ($P<.01$ for all tests for trend, Table 4). Women who reported a lifetime history of more than 12 months of lactation were less likely to have hypertension

(odds ratio [OR] 0.88, $P<.001$), diabetes (OR 0.80, $P<.001$), hyperlipidemia (OR 0.81, $P<.001$), and cardiovascular disease (OR 0.91, $P=.008$) than were women who never breast-fed. When compared with women who had never breast-fed, women who reported a cumulative lifetime duration of lactation of 13 months or more were less likely to have developed cardiovascular disease before enrolling in the WHI (OR 0.91, 95% confi-



Table 2. Association Between Months of Lactation and Obesity on Enrolling in the Women's Health Initiative Observational Study or Controlled Trials

Mo of Lactation	OR	95% CI	P	Trend
Adjusted for age, parity, race, education, income, smoking				
Never	—	—	—	.001
1–6	0.97	0.94–1.00	.07	
7–12	0.92	0.89–0.96	<.001	
13–23	0.92	0.88–0.96	<.001	
24+	0.99	0.94–1.04	.69	
Adjusted for sociodemographic, family history, and lifestyle variables*				
Never	—	—	—	0.28
1–6	1.00	0.96–1.03	.84	
7–12	0.96	0.91–1.00	.07	
13–23	0.95	0.90–1.00	.07	
24+	1.02	0.96–1.09	.56	

OR, odds ratio; CI, confidence interval.

*Specifically, age, race, parity, age at menopause, education, income, family history (of diabetes mellitus, myocardial infarction, or stroke), physical activity, energy, cholesterol, fat, fiber, and sodium intakes, tobacco history, hormone therapy use, aspirin use, multivitamin use.

dence interval [CI] 0.85–0.98, $P=.008$). Based on multivariate adjusted prevalence ratios from generalized linear models, we estimate that, among parous women who did not breast-feed compared with those who breast-fed for more than 12 months, 42.1% compared with 38.6% would have hypertension, 5.3% compared with 4.3% would have diabetes, 14.8% compared with 12.3% would have hyperlipidemia, and 9.9 compared with 9.1% would have developed cardiovascular disease, although 30% of each group would be obese when postmenopausal.

When examining fully adjusted models of the duration of lactation and prevalence of cardiovascular disease, we found no significant interactions between age at last lactation (P for interaction .58), race/ethnicity (P for interaction .35), or history of tobacco use (P for interaction .65). However, there was a significant interaction with respect to age (P for interaction .02). In fully adjusted analyses stratified by age, we found that the cardiovascular benefits of lactation decreased as women aged. Women who were 50–59 years of age on enrolling in the WHI who reported a cumulative history of lactation of 7 months or more were significantly less likely to have cardiovascular disease than similarly aged women who had never

breast-fed (OR [95% CI] 0.84 [0.71–0.99], 0.80 [0.65–0.97], and 0.75 [0.58–0.96] for women who had breast-fed for 7–12 months, 13–23 months, and 24 or more months, respectively). Among women aged 60–69, only those who reported 13–23 months of lactation were significantly less likely than women who had never breast-fed to have developed cardiovascular disease (OR 0.85, 95% CI 0.75–0.96); among women aged 70–79, there were no significant relationships between duration of lactation and prevalent cardiovascular disease.

The majority of participants in the WHI observational study (58%) reported that they had been breast-fed as infants. When we added this variable to analyses in which we adjusted for weight at age 18 or weight at birth or both with and in place of BMI category on enrollment in addition to sociodemographic, family history, and other lifestyle variables, we saw similar relationships between duration of lactation and risk of hypertension, diabetes, and hyperlipidemia (data available on request). However, the association with cardiovascular disease was somewhat attenuated and not statistically significant in the smaller population of observational study participants.

When we used Cox models to look at incident cardiovascular disease over the 7.9 years that WHI participants had been followed, we found duration of lactation was associated with a decrease in incident cardiovascular disease in univariable but not adjusted models (Table 4). However, again, there was an interaction with age (P for interaction .04, without adjusting for BMI category; P for interaction .06, with adjustment for BMI category); when we stratified the adjusted model by age, we found more cardiovascular benefits of lactation among younger women. Among women who were 50–59 on enrollment, when compared with women who had never lactated, women with a lifetime duration of 7–12 months of lactation were less likely to develop cardiovascular disease (hazard ratio 0.79, 95% CI 0.66–0.94 without adjusting for BMI category; hazard ratio 0.80, 95% CI 0.67–0.95 with adjustment for BMI category), as were women with 24 or more months of lifetime lactation (hazard ratio 0.66, 95% CI 0.50–0.86 without adjusting for BMI category; hazard ratio 0.68, 95% CI 0.52–0.89 with adjustment for BMI category) (P for trend among women aged 50–59 on enrollment was .001). Among women who were older than 60 when they enrolled in the WHI, duration of lactation was not associated with incident cardiovascular disease.

When we stratified the Cox models by parity (P for interaction .06 without adjusting for BMI category, $P=.07$ with adjustment for BMI category), we found



Table 3. Association Between Duration of Lactation and Self-Reported History of Hypertension, Diabetes, or Hyperlipidemia on Enrolling in the Women's Health Initiative Observational Study and Controlled Trials

Mo of Lactation	Hypertension	Diabetes	Hyperlipidemia
Adjusted for sociodemographic, family history, and lifestyle variables*			
Never	Referent	–	–
1–6	0.95 (0.92–0.98)	0.92 (0.85–0.99)	0.93 (0.89–0.97)
7–12	0.88 (0.84–0.91)	0.87 (0.78–0.97)	0.87 (0.82–0.93)
13–23	0.89 (0.84–0.93)	0.74 (0.65–0.84)	0.81 (0.76–0.87)
24+	0.87 (0.82–0.93)	0.89 (0.77–1.02)	0.80 (0.74–0.87)
<i>P</i> for trend	<.001	<.001	<.001
Adjusted for above plus body mass index†			
Never	Referent	–	–
1–6	0.95 (0.92–0.98)	0.91 (0.84–0.99)	0.93 (0.89–0.97)
7–12	0.88 (0.84–0.92)	0.87 (0.78–0.97)	0.88 (0.83–0.94)
13–23	0.89 (0.84–0.93)	0.75 (0.66–0.85)	0.81 (0.76–0.87)
24+	0.87 (0.82–0.92)	0.88 (0.76–1.01)	0.80 (0.73–0.87)
<i>P</i> for trend	<.001	<.001	<.001

Data are odds ratio (95% confidence interval) unless otherwise specified.

* Specifically, age, race, parity, age at menopause, education, income, family history (of diabetes mellitus, myocardial infarction, or stroke), physical activity, energy, cholesterol, fat, fiber, and sodium intakes, tobacco history, hormone therapy use, aspirin use, multivitamin use.

† Adjusted for three categories of body mass index: less than 25, 25 to less than 30, and 30 or higher.

that, when compared with women who had never lactated, women with one live birth who breast-fed for 7–12 months were significantly less likely to develop cardiovascular disease (hazard ratio 0.72, 95% CI 0.53–0.97); among women with two or three live births, lactation was associated with a significant reduction in incident cardiovascular disease only if the woman reported 24 or more months of lactation (for two live births, hazard ratio 0.58, 95% CI 0.35–0.95; for three live births, hazard ratio 0.78, 95% CI 0.63–0.98).

In analyses of the subgroup of women who had not developed cardiovascular disease before enrolling in the WHI, duration of lactation was not associated with incident cardiovascular disease.

DISCUSSION

This study found that women who breast-fed their children were less likely to have developed hypertension, diabetes, hyperlipidemia, and cardiovascular disease when postmenopausal. Women who reported longer histories of lactation had significantly lower rates of risk factors for cardiovascular disease, even after adjusting for sociodemographic and lifestyle variables, family history, and BMI category. Women who had a cumulative lifetime duration of lactation greater than 12 months were approximately 10% less likely to have developed cardiovascular disease than parous women who had never breast-fed. Although the American Academy of Pediatrics, in the interest of

promoting child health, recommends breast-feeding for the first 12 months of an infant's life,¹⁷ our study shows this recommendation also benefits maternal health. If a randomized trial were to find similar effect sizes when comparing women who breast-fed for more than 1 year with those who never breast-fed, we roughly estimate that the number needed to treat to prevent a case of maternal hypertension would be 29, to prevent a case of hyperlipidemia would be 40, to prevent a woman from developing diabetes would be 100, and to prevent a case of cardiovascular disease would be 125. These findings build on a growing body of literature that demonstrates that lactation has beneficial effects on blood pressure,¹⁸ risk of developing diabetes,^{7,8} and lipid metabolism.¹⁹ It is known that fat stores accumulate during pregnancy,²⁰ and prior studies have shown that, in populations where breast-feeding is rare, pregnancy may increase risk of cardiovascular disease.²¹ It has been hypothesized that lactation may reduce cardiovascular risk by mobilizing accumulated fat stores. However, our finding that women who breast-fed had lower rates of cardiovascular disease after adjustment for BMI category indicates that lactation does more than simply reduce a woman's fat stores. Hormonal effects, such as those of oxytocin, may have significant effects on cardiovascular profiles. Although some have considered lactation's reduction of gonadal hormones to be similar to menopause, which increases risk of cardiovascular disease, we paradoxically found lactation to



Table 4. Association Between Duration of Lactation and Cardiovascular Disease Among Participants in the Women's Health Initiative Observational Study and Controlled Trial

Mo of Lactation	Prevalent CVD*	Incident CVD†
Univariable models		
Never	Referent	Referent
1–6	1.11 (1.06–1.15)	1.08 (1.03–1.13)
7–12	0.94 (0.88–0.99)	0.92 (0.86–0.98)
13–23	0.90 (0.85–0.96)	0.93 (0.86–1.00)
24+	0.99 (0.92–1.07)	0.96 (0.88–1.05)
<i>P</i> for trend	.007	.01
Adjusted for sociodemographic, family history, and lifestyle variables‡		
Never	Referent	Referent
1–6	1.03 (0.97–1.08)	1.03 (0.98–1.08)
7–12	0.94 (0.87–1.01)	0.97 (0.90–1.03)
13–23	0.92 (0.85–1.00)	0.98 (0.91–1.05)
24+	0.86 (0.89–0.98)	0.93 (0.85–1.02)
<i>P</i> for trend	.003	.10
Adjusted for above plus body mass index§		
Never	Referent	Referent
1–6	1.03 (0.98–1.09)	1.03 (0.98–1.08)
7–12	0.95 (0.88–1.02)	0.97 (0.90–1.04)
13–23	0.93 (0.85–1.01)	0.98 (0.91–1.05)
24+	0.89 (0.80–0.98)	0.93 (0.85–1.02)
<i>P</i> for trend	.005	.12

CVD, cardiovascular disease.

Data are odds ratio (95% confidence interval) unless otherwise specified.

* Cardiovascular disease on enrollment was identified by a self-reported history of myocardial infarction, angina, congestive heart failure, peripheral arterial disease, revascularization, or stroke.

† Incident cardiovascular disease (coronary heart disease, stroke, congestive heart failure, angina, peripheral vascular disease, carotid artery disease, and coronary revascularization) was validated by physician adjudication of medical records over 7.9 years of follow-up.

‡ Specifically, age, race, parity, age at menopause, education, income, family history (of diabetes mellitus, myocardial infarction, or stroke), physical activity, energy, cholesterol, fat, fiber, and sodium intakes, tobacco history, hormone therapy use, aspirin use, multivitamin use.

§ Adjusted for three categories of body mass index: less than 25, 25 to less than 30, and 30 or higher.

protect from cardiovascular disease, although these benefits appear to wane as women reach 70 years of age and the time since a woman lactated increases.

Strengths of this study include the large and racially diverse group of women who participated in the WHI. However, all observational studies may be subject to residual confounding. Lifetime duration of lactation as well as history of diabetes, hyperlipid-

Table 5. Association Between Duration of Lactation and Prevalence of Cardiovascular Risk Factors* With Additional Adjustment for Weight at Age 18, Birth Weight, and Whether a Woman was Breast-Fed as an Infant

Mo of Lactation	OR	95% CI	<i>P</i> Trend
Obesity			
Never	Referent		.67
1–6	1.00	(0.95–1.05)	
7–12	0.94	(0.87–1.00)	
13–23	0.94	(0.87–1.02)	
24+	1.07	(0.98–1.18)	
Hypertension			
Never	Referent		<.001
1–6	0.95	(0.91–0.99)	
7–12	0.87	(0.82–0.93)	
13–23	0.90	(0.85–0.97)	
24+	0.88	(0.81–0.95)	
Diabetes			
Never	Referent		.02
1–6	0.94	(0.84–1.04)	
7–12	0.91	(0.78–1.06)	
13–23	0.69	(0.58–0.84)	
24+	0.99	(0.82–1.19)	
Hyperlipidemia			
Never	Referent		<.001
1–6	0.91	(0.86–0.96)	
7–12	0.84	(0.78–0.91)	
13–23	0.80	(0.73–0.87)	
24+	0.83	(0.74–0.93)	
Cardiovascular disease			
Never	Referent		.26
1–6	1.06	(0.99–1.13)	
7–12	0.97	(0.88–1.06)	
13–23	0.98	(0.88–1.09)	
24+	0.94	(0.82–1.07)	

OR, odds ratio; CI, confidence interval.

* These analyses include only those participants in the WHI observational study ($n=78,825$) who provided information on their weight at age 18, birth weight, and whether they were breast-fed as an infant. All models are adjusted for age, race, parity, smoking, education, income, age at menopause, physical activity; diet (energy, cholesterol, fat, fiber, and sodium intakes), use of postmenopausal hormone therapy, aspirin, and, multivitamins, and family history of diabetes, myocardial infarction, or stroke, in addition to these variables.

emia, and prevalent cardiovascular disease were all self-reported. The measure of lactation used in this study does not allow estimation of the intensity or exclusivity with which women breast-fed their infants. It is likely that more powerful effects would be seen with exclusive breast-feeding. 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 tend to overreport, whereas women with longer durations tend to underreport.²² Presuming this misclassification



is nondifferential with respect to the outcomes examined, it would attenuate estimates of dose–response associations between duration of lactation and later health. Nonetheless, we observed significant dose–response associations between duration of lactation and risk factors for cardiovascular disease. Some have hypothesized that women who are able to prolong breast-feeding may lead “less stressful” lives, which may lower their risk of cardiovascular disease.²³ Although we controlled for socioeconomic variables (education, income, race, parity, and tobacco use) that have been associated with life stress,²⁴ other factors may remain. In addition, studies have linked obesity and insulin resistance to difficulties with breast-feeding,²⁵ suggesting that decreased duration of lactation could be a marker for an existing abnormal metabolic profile. Regrettably, data on maternal cardiovascular risk at the time of lactation was not collected by the WHI. Women who were breast-fed by their mothers may be more likely to breast-feed their children.²⁶ If early-life exposure to breast milk affects cardiovascular risk profiles later in life, models without this variable may be subject to residual confounding. Our models, which included this variable, were similar to other estimates, in keeping with other recent studies that have provided little evidence of a protective influence of being breast-fed on cardiovascular disease risk factors, incidence, or mortality later in life.²⁷

In conclusion, this study shows that lactation may play a significant role in reducing risk of cardiovascular disease. This implies that recommendations that women breast-feed their infants for the first year of life should be endorsed for the benefit of both maternal and child health.

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