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Reproductive history and physical functioning in midlife: The Bogalusa Heart Study

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Abstract

Objective—To examine the relationship between reproductive history, pregnancy complications, and later physical function.

Study design—The Bogalusa Heart Study is a long-running study of cardiovascular health in a semirural community. 761 women were interviewed about their pregnancy historyand complications,and underwent tests of physical function. Logistic models for dichotomous outcomesand linear models for continuous outcomes were used, adjusted for covariates.

Main outcome measures—Overall scores on the Short Physical Performance Battery (SPPB), which combines scores for balance, gait speed, and chair stands. Additional tests were a 6-minute walk, knee extension strength, grip strength, and a pegboard challenge.

Results—Nulliparity was associated with lower scores on the walking and balance portions of the SPPB, less distance covered in the 6-minute walk, less knee and grip strength, and higher pegboard time, especially among pre-menopausal women. A history of gestational diabetes was

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Contributors

Emily W. Harville conceived and designed the study, participated in data collection, and analysed the data.
Wei Chen conceived and designed the study, and participated in data collection.
Jack Guralnik participated in data collection, and analysed the data.
Lydia A. Bazzano conceived and designed the study, and participated in data collection.
All authors contributed to drafting the manuscript.

Conflict of interest

The authors declare that they have no conflict of interest.

Ethical approval

The BiCEPS and Bogalusa Babies studies were approved by the Institutional Review Board of Tulane University.
All participants provided written informed consents.

Provenance and peer review

This article has undergone peer review.

Research data (data sharing and collaboration)

Data from the Bogalusa Heart Study are available through the NHLBI BioLINCC repository. More recent data are available to qualified researchers upon application.

associated with more problems on the walk portion of the SPPB (aOR 2.44, 1.06–5.65), higher chair stand time, and lower knee strength. Young age at first birth (<16 or 18 years) was associated with a shorter chair stand time and a better pegboard score.

Conclusions—Nulliparity was associated with worse physical functioning, while high parity and early pregnancy were not, suggesting that fertility is associated with better health later in life. Pregnancy complications were associated with worse physical functioning, even after controlling for body mass index. Future studies should attempt to establish the pathways by which reproductive health relates to overall physical functioning.

Keywords

Parity; walk test; hand strength; gestational diabetes; hypertension; pregnancy-induced

Introduction

Pregnancy affects all aspects of a woman's body, often permanently. The increased weight, unusual weight distribution, and joint laxity of pregnancy [1] could lead to permanent harm to joints and associated movement issues. The increased cardiometabolic risk associated with pregnancy complications might also lead to physical disability.[2] However, relatively few studies have empirically addressed the question of whether pregnancy and reproductive history affects later physical function. Very high parity (usually 4+ births) and adolescent pregnancy have been associated with increased disability [3, 4], worse physical role functioning [5, 6], and physical decline [6]. Most previous studies have been conducted in women aged 65+. Both nulliparity and high parity [7] as well as pregnancy complications [8, 9] are associated with increased cardiometabolic risk later in life. Given the associations between cardiometabolic risk and physical function [10], it is likely that complications such as gestational diabetes and pre-eclampsia, or giving birth to a low birthweight baby, are also associated with reduced physical function. Infertility may be an indicator of worse underlying health [11], which can reveal itself in worsened physical function later in life.

In this analysis, we explored whether reproductive history (parity, fertility) and pregnancy complications (pregnancy-induced hypertension, gestational diabetes, preterm birth, low birthweight) are associated with indicators of physical health in midlife, in a community-based, biracial cohort. We hypothesized that 1) high parity would be most strongly associated with functional outcomes associated with mobility, possibly due to associated joint changes; 2) infertility would be associated with overall worse functioning; and 3) pregnancy-induced hypertension and gestational diabetes, the complications most strongly associated with later cardiometabolic health, would be most strongly associated with physical function, largely mediated by BMI.

Methods

The Bogalusa Heart Study is a series of studies of cardiovascular risk, in a semirural, biracial population (65% white and 35% black), founded by Dr. Gerald Berenson in 1973. This analysis combines results from two follow-up studies conducted in 2011–2016: Bogalusa Babies, which examined reproductive outcomes within the BHS, and BiCEPS (Brain,

CognitivE and Physical performance Study), which links vascular risk factors across the lifespan with cognitive and physical performance. 1651 women participated in Bogalusa Babies; of those, 761 also participated in BiCEPS and had data on at least one exposure and outcome. The most common reason for not participating in both was not being available to visit the clinic and in most cases women completed both studies on the same day, although this was not a requirement. Compared to those who participated in Babies but not BiCEPS, the group who also participated in BiCEPSwere more likely to be postmenopausal (58% vs. 46%, $p<0.01$, mostly due to age), previous smokers (38% vs. 21%, $p<0.01$), and were less likely to have higher education (26% vs. 33%, $p<0.01$). Pre-pregnancy BMI was somewhat higher (22.4 vs. 21.5, $p<0.01$). There were no differences with respect to parity, race, smoking during pregnancy, orage at first pregnancy.

Exposures

All reproductive history variables in this analysis were self-reported, although women were encouraged to consult a baby book, if they had one. During the interview, women were asked whether they had ever been pregnant, the outcome of each pregnancy, complications, and whether they took any fertility drugs or received any medical procedures to help them get pregnant. Women were also asked whether they ever tried to get pregnant and were unable to. Women who answered “yes” to any one of the fertility-related questions were considered to have reported fertility difficulties. Reliability between self-reported use of fertility treatment and medical records has been found to be reasonably high,[12] and though self-report may underestimate clinical fertility difficulties, it provides a reasonable estimate of infertility burden with high specificity.[13] Reproductive history assessed included number of pregnancies, number of births, and adolescent pregnancy (<16 or <18 years at first pregnancy). Pregnancy complications assessed included low birthweight (<2500 g), preterm birth, gestational diabetes mellitus (GDM), and miscarriage. Pre-eclampsia and pregnancy-related hypertension were combined for a hypertensive disorders of pregnancy outcome. Mothers remember the birthweight and gestational age of their infants quite well, even after many years [14, 15]. Recall has been shown to be highly specific (>90%) for hypertensive disorders [16] and accurate for reports of gestational diabetes (GDM) (specificity=98%, sensitivity=92%) [17]. Miscarriage is mostly accurately recalled when it occurs late in pregnancy or requires medical attention [18]; still, there is no other plausible source of information for history of early miscarriage besides self-report. All exposures were defined as the occurrence at any pregnancy, so if a woman had multiple pregnancies but reported the outcome in only one, she was defined as having had a history of the complication.

Outcomes

The main outcome was the Short Physical Performance Battery (SPPB), which combines scores on balance (side-by-side, semi-tandem, and tandem stands), gait speed (better of two times at usual pace over a 4-m course), and chair stands (time for 5 chair stands, arms crossed, without using arms, done as quickly as possible). Scores were computed based on the instructions for the SPPB [19]. The full SPPB is scored from 0 to 12, with 12 being the best function. Components of the SPPB were each scored from 0 to 4, then dichotomized as

listed in tables 3 and 5. Alternate dichotomizations were also analyzed, and results were similar except where presented below.

Additional indicators of physical function included distance travelled during the 6-minute walk, knee extension strength (repeated three times per leg and averaged), grip strength (averaged across both hands), and time completing a pegboard challenge with the dominant and non-dominant hands. If a task was attempted but not completed, it was recorded as 1 more or less than the maximum or minimum (depending on whether higher or lower numbers were associated with worse function). As time to complete the pegboard task was highly skewed, it was log-transformed for analysis.

Analysis

Each exposure was examined as a predictor of the SPPB score, components of the SPPB, and the other physical function indicators. Models of fertility and parity were first adjusted for age at interview, menopausal status (self-defined as having gone 12 months without a period), race, education, and smoking, and the next set of models were also adjusted for BMI at time of outcome measure (a potential intermediate as well as confounder). Models of pregnancy complications were also adjusted for age at first pregnancy. Logistic models for dichotomous and linear models for continuous outcomes were used with multiple imputation to account for missing data on covariates; most commonly missing was age at first pregnancy (1.6%). Interactions with menopausal status were examined, and where significant, results were stratified as indicated. The BiCEPS and Bogalusa Babies studies were approved by the Institutional Review Board of Tulane University.

Results

Given the relatively young age of the sample, the large majority had the highest category of performance for each of the three components of the SPPB (Table 1), though approximately 10% scored in the lower categories for each outcome. 12% had <10 on total SPPB, which indicates impaired functioning for a relatively young age group. Mean age at interview was 47.7 years (Table 2), and about a third of the study population was black and two-thirds white. A fairly large number had a birth at a young age (22% before 18 years), and the history of low birthweight (18%), preterm birth (15%), and gestational diabetes (10%) are consistent with general population estimates. 58% reported being in menopause; 12 (1.6%) women reported use of hormone therapy.

As both nulliparity and high parity have been associated with adverse health, parity was considered as a nominal variable (table 3). For the SPPB, we found an interaction with menopausal status: among pre-menopausal women, nulliparity was associated with lower scores on the total, chair, walking and balance portions of the SPPB; among post-menopausal women, this held true only for balance. Among pre-menopausal women, there was also some indication that higher parity was associated with lower balance scores; in post-menopausal women, the association, if any, when in the opposite direction. Among post-menopausal women, higher parity was also associated with lower scores on the walk portion, but adjustment for confounding reduced the association. For the other indicators of physical performance (table S1), there was no interaction with menopausal status, and

nulliparity was associated with less distance covered in the 6-minute walk, lower knee and grip strength, and higher pegboard time; there was no evidence for higher parity being associated with worse performance on these measures of performance.

History of gestational diabetes (Table 3 and S2) was associated with more problems on the walk portion of the SPPB (aOR 2.44, 1.06–5.65), as was hypertensive disorders (aOR 2.13, 1.10–4.13), though this was somewhat attenuated by adjustment for BMI (aOR 1.85, 0.93–3.68). Young age at first birth (<16 or 18) was associated with lower chair stand time and better pegboard score (Table S2), both indicating better health. Gestational diabetes was associated with higher chair stand time and lower knee strength. Hypertensive disorders were associated with higher pegboard scores. The only interaction with menopausal status seen was for preterm birth; history of preterm birth was associated with a lower walk score among pre-menopausal women (fully adjusted OR 3.65, 1.09–12.23) but not post-menopausal women (1.06, 0.41–2.77).

Discussion

This exploration of associations between pregnancy history and physical performance at midlife found a few associations. Contrary to hypothesis, higher parity was not associated with worse functional outcomes, although the number of grand multipara in our study is small, nor did. we find evidence that early pregnancy was associated with worse health, and in some cases early pregnancy was associated with better functioning. This may suggest fertility is an indicator of better health. Overall, in our study, nulliparity was associated with worse outcomes, which may indicate overall worse health. We do not know why the nulliparous women did not give birth (we did not ask extensively about reasons for lack of children), and whether the nulliparity was voluntary or involuntary. We did not find associations with reported fertility difficulties, but, among other explanations, most of these women gave birth at least 20 years ago, when assisted reproductive technology was less common. This means that our sample is more likely to represent those who experienced involuntary (health-related) rather than choice or social infertility, than later samples. Aspects of health associated with infertility might also be associated with later worse functioning, or women who perceive their health to be worse might choose not to bear children. People with disabilities or higher levels of health risk factors are less likely to marry [20] and bear children [21]. Children and family may also provide social ties that are conducive to better health. The relationship with nulliparity was stronger in those who were pre-menopausal, which may suggest health issues in those women leading to early disability.

There was also some evidence that hypertensive disorders of pregnancy and GDM were associated with increased risk of poor physical function. This would be consistent with previous studies indicating increased risk of cardiometabolic disorders following such complications [22, 23], and between cardiometabolic risk and poor physical function. Some of these associations were partly accounted for by BMI, but overall, the lack of effect of adjustment for BMI is somewhat surprising, as a likely mechanism for any association between pregnancy history and late health might be the weight gain that often accompanies pregnancy. Hypertension and diabetes during pregnancy often precede the conditions becoming permanent conditions later in life. These associations are not adjusted for later

hypertension or diabetes, but such an association would simply indicate the pathway by which these pregnancy conditions were having their effect.

Menopause is associated with reduced grip strength [24], standing balance [25], role-physical functioning [26], and increased functional limitation [27]. There is little research addressing the relationship between age at menopause and reproductive history. Most focuses on late pregnancy as a predictor of late menopause [28], and higher parity has been variously associated with later menopause [29] or not associated at all [30]. This sample was fairly evenly split between pre- and post-menopausal women, and all analyses were adjusted for menopausal status. Therefore, it seems unlikely that any results seen were mediated by menopausal status, although it is possible that the interrelationships between pregnancy, menopause, and hormonal levels affect cardiovascular and physical health.

The sample under study was still fairly young. It may be that only in later life that strong associations are seen. Particularly for complications like low birthweight and preterm birth, which are less strongly associated with cardiometabolic risk [9, 31], a longer follow-up time or larger sample size may be necessary to find differences. Most people in middle age function at a high level and the SPPB was designed to measure function in older persons. However, it did identify a subset of even this population that had functional problems, though the fact that this subset was relatively small means that power was limited. Even though it has a ceiling effect, because the tasks are relatively easy, it can still identify younger persons with functional limitations. Also, physical performance measures such as hand grip strength have been shown to predict morbidity many years later [32].

This study indicated that nulliparity was associated with worse physical functioning in midlife, while high parity and early pregnancy were not. This may indicate that fertility is associated with better health later in life. Also, pregnancy complications were associated with worse physical functioning later in life, even controlling for BMI. Future studies should attempt to establish the pathways by which reproductive health relates to overall physical functioning.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations

BMI	body mass index
BHS	Bogalusa Heart Study
BiCEPS	Brain, CognitivE and Physical performance Study

GDM	gestational diabetes mellitus
SPPB	Short Physical Performance Battery
aOR	adjusted odds ratio

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Highlights

- Nulliparity is associated with worse physical function in midlife, suggesting that infertility may indicate overall worse health.
- In this study there was no evidence that early pregnancy (<18 years) or high parity was associated with worse physical function in midlife.
- Hypertensive disorders of pregnancy and gestational diabetes were associated with poor physical function in midlife.
- Adjustment for body mass index had little effect on the findings.

Table 1

The Short Physical Performance Battery, participants in the Bogalusa Babies and BiCEPS studies, 2011–2016, n=761 Balance

0 (not attempted or: side-by side <10 sec)	2	0.3	
1	11	1.5	
2	13	1.7	
3	41	5.4	
4 (side-by-side, semi-tandem, tandem each 10 sec or more)	690	91.2	
4m walk			
1 (>8.7 sec)	1	0.1	
2 (6.21–8.70 sec)	10	1.3	
3 (4.82–6.20 sec)	61	8.1	
4 (<4.82 sec)	681	90.4	
chair			
0 (unable/>60 sec)	9	1.3	
1 (>16.7 sec)	60	8.3	
2 (13.70–16.7 sec)	106	14.7	
3 (11.2–13.7)	111	15.4	
4 (<=11.2)	433	30.2	
total			
<8	8	1.1	
8–9	87	12.4	
10	98	14.0	
11	121	17.3	
12	395	56.3	
	mean	SD	range
6-minute walk, meters	414	80	202–676[a]
length of time for 10 chair stands (seconds)	23.6	6.8	6.1–61.6
knee strength, average across 3 attempts per knee	44	14	5.1–86.3
average grip strength (kg)	28	6.5	4.4–49.7
pegboard dexterity, time in sec, dominant hand	76	28	44–240[b]
pegboard dexterity, time in sec, nondominant hand	82	31	47–283[b]

[a] if attempted but not completed assigned minimum value-1

[b] if attempted but not completed assigned maximum value+1

Table 2

Participants in the Bogalusa Babies and BiCEPS studies, 2011–2016, n=761

	overall					Total <10					Total≥10					
	N	%				N	%				N	%		p for difference		
race																
black	280	36.8				50	47.6				410	66.9		<0.01		
white	480	63.2				55	52.4				203	33.1				
menopausal status at interview																
post-menopausal	440	58.1				64	61.0				352	57.7				
pre-menopausal	317	41.9				41	39.1				258	42.3				
Age at menopause (post- menopausal only)																
<45	179	40.0				21	32.3				149	41.9				
45–<50	111	24.8				20	30.8				82	23.0				
50–<55	98	21.9				14	21.5				79	22.2				
55+	59	13.2				10	17.9				46	12.9				
total parity																
0	101	13.4				19	18.3				77	12.7		0.27		
1	131	17.4				14	13.5				110	18.1				
2	297	39.5				37	35.6				245	40.4				
3	151	20.1				20	19.2				118	19.4				
4+	72	9.6				14	13.5				57	9.4				
education																
<12 years	66	8.7				17	16.2				43	7.0		<0.01		
12	248	62.6				44	41.9				185	30.2				
some college/AA	250	32.9				29	27.6				211	34.4				
college degree or higher	196	25.8				15	14.3				174	28.4				
ever smoked	285	37.5				47	44.8				215	35.1		0.06		
ever smoked in pregnancy	147	19.3				26	24.8				107	17.4		0.07		
any type of fertility difficulties	136	17.9				12	11.4				115	18.7		0.07		

	overall					Total <10					Total≥10					
	N	**%**				**N**	**%**				**N**	**%**		**p for difference**		
birth <16 years	45	6.9				5	5.8				36	6.8		0.75		
birth <18 years	146	22.3				22	25.6				115	21.6		0.41		
any history of low birthweight	119	18.2				21	24.7				89	16.7		0.07		
any history of preterm birth	98	14.9				10	11.6				80	14.9		0.42		
any history of gestational diabetes	66	10.0				10	11.6				53	9.9		0.62		
any history of hypertensive disorders	139	21.1				17	19.8				114	21.3		0.75		
any miscarriage	160	21.0				22	21.0				132	21.5		0.9		
	mean	median	SD	min	max	mean	median	SD	min	max	mean	median	SD	min	max	p
age at interview	47.7	48.4	5.2	32.5	57.8	48.8	49.0	4.9	35.9	56.7	47.5	48.0	5.3	32.5	56.7	0.03
age at 1st pregnancy	22.	21.0	5.3	14.0	45.0	21.4	20.0	5.6	14.0	45.0	22.3	21.0	5.2	14.0	45.0	0.13
age at last pregnancy	28.3	28.0	5.9	15.0	47.0	28.1	27.0	5.7	17.0	45.0	28.4	28.0	5.9	15.0	45.0	0.63
BMI at last visit	32.	31.1	8.3	17.	67.	36.	33.4	10.	19.	62.	31.	30.3	7.6	17.9	62.	<0.
pre-pregnancy BMI	022.5	21.2	5.1	915.0	744.7	023.7	21.9	55.7	715.9	542.1	222.3	21.1	4.9	15.0	542.	010.04
average pregnancy weight gain (lbs)	30.9	28.3	15.3	0.0	85.0	27.4	25.0	12.4	0.0	85.0	31.1	28.3	15.3	0.0	85.0	0.01

Table 3

Associations between parity and the Short Physical Performance Battery, women in the Bogalusa Heart Study (n=761)

	total (<10)		chair (≤2)		walk (≤3)		balance (≤2)	
	OR[a]	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Total parity								
pre-menopausal								
0	6.04	1.48–6.23	1.97	1.05–3.72	2.56	1.03–6.36	6.73	2.06–22.04
+ adjustment[a]	3.87	1.77–8.45	2.30	1.17–4.55	3.56	1.30–9.74	10.23	2.81–37.26
+ adjustment for BMI	2.85	1.24–6.59	1.95	0.96–3.94	2.37	0.78–7.23	8.90	1.69–47.01
3+	0.80	0.37–1.71	0.79	0.43–1.47	1.35	0.55–3.31	0.22	0.03–1.74
+ adjustment[a]	0.57	0.24–1.37	0.59	0.29–1.20	0.69	0.23–2.05	0.09	0.01–0.84
+ adjustment for BMI	0.62	0.25–1.55	0.62	0.30–1.27	0.87	0.27–2.75	0.09	0.01–1.05
post-menopausal								
0	0.59	0.20–1.72	0.72	0.32–1.61	1.15	0.43–3.08	4.47	1.31–15.20
+ adjustment[a]	0.56	0.18–1.72	0.77	0.33–1.81	1.48	0.50–4.44	3.47	0.91–13.24
+ adjustment for BMI	0.54	0.18–1.64	0.70	0.30–1.61	1.17	0.41–3.32	4.45	1.23–16.07
3+	1.53	0.88–2.68	1.11	0.69–1.79	2.06	1.11–3.81	1.46	0.47–4.55
+ adjustment[a]	1.30	0.70–2.41	0.88	0.52–1.49	1.56	0.79–3.06	2.02	0.54–7.52
+ adjustment for BMI	1.24	0.67—2.32	0.86	0.51–1.46	1.49	0.75–2.96	1.79	0.46–6.91

[a]adjusted for age, menopausal status, race, smoking, education

Table 4

History of pregnancy complications and the Short Physical Performance Battery, women in the Bogalusa Heart Study

	total (<10)		chair (≤2)		walk (≤3)		balance (≤2)	
	OR	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
any fertility difficulties	0.56	0.30–1.06	0.72	0.45–1.16	0.74	0.37–1.48	0.60	0.18–2.02
+ adjustment[a]	0.61	0.30–1.23	0.81	0.49–1.35	1.00	0.48–2.08	0.83	0.24—2.90
+ adjustment for BMI	0.56	0.28–1.15	0.80	0.48–1.32	0.97	0.46–2.04	0.78	0.22–2.80
birth<16 years	0.85	0.33–2.24	0.89	0.41–1.91	2.52	1.11–5.73	1.06	0.14–8.32
+ adjustment[a]	0.42	0.15–1.19	0.50	0.22–1.16	1.20	0.48–3.04	0.56	0.06–4.88
+ adjustment for BMI	0.40	0.14–1.15	0.50	0.22–1.14	1.14	0.45–2.90	0.37	0.03–4.13
birth<18 years	1.25	0.74–2.12	1.50	0.98–2.29	2.61	1.48–4.59	0.58	0.13–2.63
+ adjustment[a]	0.70	0.38–1.29	1.05	0.65–1.69	1.53	0.82–2.86	0.33	0.07–1.59
+ adjustment for BMI	0.71	0.38–1.30	1.05	0.66–1.69	1.55	0.82–2.90	0.27	0.05–1.48
low birthweight	1.64	0.95–2.82	1.18	0.74–1.90	1.85	1.00–3.42	2.57	0.85–7.82
+ adjustment[b]	1.34	0.74–2.41	0.93	0.56–1.55	1.39	0.72–2.70	2.30	0.73–7.29
+ adjustment for BMI	1.30	0.71–2.36	0.92	0.55–1.54	1.32	0.68–2.58	1.81	0.53–6.14
preterm birth	0.75	0.37–1.51	0.84	0.49–1.44	1.56	0.80–3.07	2.35	0.72–7.66
+ adjustment[b]	0.87	0.42–1.80	0.95	0.54–1.67	1.77	0.86–3.63	2.57	0.77–8.57
+ adjustment for BMI	0.86	0.41–1.79	0.94	0.54–1.66	1.70	0.82–3.52	2.25	0.63–8.03
gestational diabetes	1.20	0.59–2.46	1.70	0.97–2.98	1.73	0.81–3.71	1.53	0.33–6.98
+ adjustment[b]	1.71	0.79–3.69	2.15	1.19–3.89	2.56	1.11–5.93	2.10	0.44–10.06
+ adjustment for BMI	1.55	0.71–3.38	2.09	1.15–3.79	2.44	1.06–5.65	1.80	0.36–9.02
hypertensive disorders	0.91	0.52–1.61	0.79	0.50–1.27	1.64	0.90–2.98	1.53	0.47–4.94
+ adjustment[b]	1.10	0.59–2.04	0.83	0.50–1.38	2.13	1.10–4.13	2.09	0.62–7.08
+ adjustment for BMI	0.90	0.47–1.71	0.77	0.46–1.30	1.85	0.93–3.68	1.03	0.27–3.98
Miscarriage	0.97	0.58–1.61	1.07	0.71–1.61	0.82	0.44–1.54	0.31	0.07–1.30
+ adjustment[b]	1.01	0.58–1.75	1.07	0.69–1.66	0.93	0.48–1.80	0.33	0.08–1.44
+ adjustment for BMI	1.06	0.60–1.85	1.10	0.71–1.70	1.01	0.51–1.99	0.38	0.08–1.69

[a] adjusted for age, menopausal status, race, smoking, education

[b] adjusted for age, menopausal status, race, smoking, education, age at first pregnancy