Black–White Differences in Hysterectomy Prevalence: The CARDIA Study

Julie K. Bower, MPH, Pamela J. Schreiner, PhD, Barbara Sternfeld, PhD, and Cora E. Lewis, MD, MSPH

Objectives. We evaluated the cross-sectional association between race and hysterectomy prevalence in a population-based cohort of US women and investigated participant characteristics associated with racial differences.

Methods. The cohort consisted of 1863 Black and White women in the Coronary Artery Risk Development in Young Adults (CARDIA) study from 2000 to 2002 (years 15 and 16 after baseline). We used logistic regression to examine unadjusted and multivariable adjusted odds ratios.

Results. Black women demonstrated greater odds of hysterectomy compared with White women (odds ratio [OR]=3.52; 95% confidence interval [CI]=2.52, 4.90). Adjustment for age, educational attainment, perceived barriers to accessing medical care, body mass index, polycystic ovarian syndrome, tubal ligation, depressive symptoms, age at menarche, and geographic location minimally altered the association (OR=3.70; 95% CI=2.44, 5.61). In a subset of the study population, those with directly imaged fibroids, the association was minimally attenuated (OR=3.47; 95% CI=2.23, 5.40).

Conclusions. In both unadjusted and multivariable adjusted models, Black women, compared with White women, had increased odds of hysterectomy that persisted despite adjustment for participant characteristics. The increased odds are possibly related to decisions to undergo hysterectomy. (*Am J Public Health.* 2009;99:300–307. doi:10.2105/AJPH.2008.133702)

Hysterectomy is one of the most frequently performed surgeries among women in the United States. Rates of hysterectomy far exceed those in a majority of other Western countries, which may be partially because of nonclinical factors.[1] Several studies report higher rates of hysterectomy among Black women compared with White women, often attributing the disparity to differences in socioeconomic or psychosocial factors.[2–5] However, the literature is incomplete, possibly because of limitations of the study designs used to evaluate hypotheses regarding factors associated with differential treatment decisions. In fact, most available studies are not population-based or have otherwise restricted samples that preclude adequate assessment of contributors to racial differences.

Because most hysterectomies are performed for noncancer causes,[5] there is growing interest in understanding differences in antecedents to hysterectomy that may explain the disproportionately higher frequency among Black women. The initial step in this investigation was to identify individual characteristics that may help to explain why more Black women undergo hysterectomy in the United States compared with White women. Individual physiological and nonclinical characteristics likely influence one's decision to undergo hysterectomy or a clinician's recommendation for treatment.

In addition to clinical indications, including presence of fibroids or persistent vaginal bleeding (for which the most appropriate method of treatment is not always clear), those attributes most strongly related include differences in access to health care, highest level of education, body mass index (BMI), and various lifestyle behaviors.[4–6] One proposed hypothesis is that individuals with lower socioeconomic status may be less knowledgeable about alternatives to hysterectomy and might subsequently delay seeking care longer, until gynecological problems are too severe to pursue nonhysterectomy treatment options.[6,7] Such assertions suggest that knowledge about and access to alternative treatments may differ among social, ethnic, and geographic groups. Alternately, information about less radical treatments may be differentially communicated to or accepted by patients.

With a large, biethnic, population-based cohort of women, we cross-sectionally examined differences in hysterectomy prevalence between Black and White women and potential correlates of racial differences. Our primary objective was to identify characteristics associated with observed racial differences. We hypothesized that racial differences could be explained by statistically controlling for participant characteristics related to hysterectomy status—most notably psychosocial factors and medical history. The establishment of attributes that explain current racial disparities may reveal potential modifiable factors that influence decisions to undergo hysterectomy—with the ultimate goal of better identifying candidates for alternative and less radical treatments. Further, this could lead to tailored interventions that more effectively help women consider the multiple treatment options available.

METHODS

Study Participants and Procedures

The Coronary Artery Risk Development in Young Adults (CARDIA) study is a population-based observational study aimed at examining how risk factors for heart disease develop among 5115 men and women aged 18 to 30 years at the time of enrollment in 1985 and 1986 at 4 geographically distributed sites (Birmingham, AL; Chicago, IL; Minneapolis, MN; and Oakland, CA). The sample was recruited to obtain balanced subgroups by gender, race (non-Hispanic Black or non-Hispanic White), education, and age. At baseline, 2787 women (1480 Black women and 1307 White women) were enrolled. Data for this study were collected from 2033 women who attended the year-15 follow-up examination (73% of the surviving cohort); CARDIA recruitment and methodology details are described elsewhere.[8] In brief, CARDIA

investigators collected data at baseline and at follow-up examinations 2, 5, 7, 10, and 15 years later. At each examination, study participants completed questionnaires regarding health status, health behaviors, medical history, and psychosocial characteristics. Additionally, participants contributed blood samples and underwent various physiological measurements. Women who attended the year-15 examination were also invited to participate in an ancillary study (the CARDIA Women's Study [CWS]).

In the CWS, researchers examined associations of serum androgens, polycystic ovaries assessed with ultrasonography, and clinical features of polycystic ovarian syndrome (PCOS) in relation to coronary artery calcium development. Therefore, only women with coronary artery calcium information available from the year-15 examination were eligible for screening for CWS; approximately 80% of eligible participants volunteered for the coronary calcium component. Other CWS exclusion criteria were current pregnancy (or less than 3 months postdelivery), uncertainty about pregnancy status, or bilateral oophorectomy. A total of 1163 women who met eligibility criteria agreed to participate in CWS. One hundred nineteen eligible women chose not to participate in CWS, most commonly because they lived too far from the clinic or were unwilling or unable to attend the additional assessment session. Thirty-six percent of women who refused participation were Black and 64% were White. An institutional review board at each site approved all study procedures; written informed consent was obtained from study participants prior to assessments.

Measures

CARDIA year 15. Hysterectomy status was ascertained by self-report at baseline and at each follow-up examination to determine total self-reported hysterectomy prevalence by year 15. Women were asked if they had undergone a hysterectomy and, if yes, to specify existing conditions at the time of hysterectomy (including abnormal Papanicolaou test, endometriosis, infection, fibroids, prolapse, pregnancy complications, and cancer). Women in CARDIA who participated in CWS underwent transvaginal ultrasonography that confirmed self-reported hysterectomy and oophorectomy status.

Women were excluded from analyses if self-reported hysterectomy was inconsistent with ultrasonography (n=14), no hysterectomy status data were available (where hysterectomy status was missing on the questionnaire or a woman did not attend the examination; n=59), or hysterectomy status could not be determined because of inconsistent questionnaire responses (where hysterectomy was reported at an earlier examination with no history of hysterectomy reported at later examinations; n=6). Participants were also excluded if data were missing for the characteristics under study. Sample size ranged from 1141 to 2033, depending on the analysis.

Participants self-reported race, years of education completed, smoking and alcohol-use history, ability to obtain needed health services, and difficulties in paying for medical services. Items assessing access to health services were measured on a 4- or 5-point Likert scale and subsequently reduced to dichotomous indicators signifying presence or absence of a barrier to care. Participants also self-reported parity, medications, PCOS, fibroids (among women who self-reported hysterectomy in CARDIA and CWS), tubal ligation, and age at menarche. Blood pressure and lipids were measured with methods described previously.[8]

Depressive symptoms were measured with a 20-item modified version of the Center for Epidemiologic Studies Depression (CES-D) Scale.[9] The CES-D score was examined as both a continuous and dichotomous variable. Participants with a score of 16 or higher were characterized with depressive symptoms.

Physical activity was measured with an interviewer-administered modified version of the Minnesota Leisure Time Physical Activity Questionnaire. The instrument assesses 13 activity categories covering various intensity levels and obtains the following information: whether the activity was performed at any time in the prior year, number of months that the activity was performed, and number of months that the activity was performed frequently. The total score represented total amount of moderate-to-vigorous physical activity expressed in exercise units. Further details of the scoring system have been described previously.[10]

Certified technicians measured height, weight, and waist circumference with a standardized protocol previously described.[8] Body weight was measured to the nearest 0.2 kg, and both height and waist circumference were measured to the nearest 0.5 cm.

CARDIA Women's Study Year 16. Efforts were made to conduct transvaginal ultrasound examinations during the first 10 days of the cycle for women with regular menstrual cycles. Sixty-four percent of exams occurred within this time frame. For women whose cycles were greater than 34 days, who were amenorrheic, or who reported current oral contraceptive pill use, no preference for day of examination was specified. The ultrasound determined number of ovaries, presence of a uterus, and number and size of fibroids and ovarian follicles or cysts. Sonographers were certified by the American Registry of Diagnostic Sonographers and used a 5- to 7.5-MHz transvaginal probe. Examinations were standardized across study centers; quality control measures performed throughout the data collection process ensured adherence to the protocol.

Thirteen milliliters of blood were collected in a serum-separator tube and were assayed by the OB/GYN Research and Diagnostic Laboratory at the University of Alabama, Birmingham. Total testosterone, sex hormone–binding globulin, follicle-stimulating hormone, and luteinizing hormone levels were measured. Free testosterone was computed with a previously described method based on total testosterone and sex hormone–binding globulin.[11]

Statistical Analyses

We examined participants with self-reported or ultrasound-confirmed hysterectomy without bilateral oophorectomy (1 or 2 ovaries remaining) and with bilateral oophorectomy. We compared these groups with women who had no evidence or report of hysterectomy within race with the Student t test and χ^2 test. We also examined the same characteristics separately by hysterectomy status (no evidence or report of hysterectomy and any type of hysterectomy) comparing Black and White women.

We used logistic regression to examine the relationship between race and self-reported hysterectomy, with hysterectomy coded as a dichotomous variable (yes or no). In the primary analysis, we pooled women with hysterectomy (with or without oophorectomy). We evaluated the following characteristics as potential

confounders of the association between race and hysterectomy: age, age at menarche, geographic site, education, access to medical care, ability to pay for medical care, depressive symptoms, BMI (weight in kilograms divided by height in meters squared), PCOS, and tubal ligation. We also evaluated potential statistical interactions between race and those factors that differed by race. The final model examined unadjusted and multivariable adjusted odds ratios in the full sample. In a secondary analysis, we applied our final model to the subsample of women with self-reported fibroid history (women who had hysterectomy) and those who participated in CWS, which included an

TABLE 1—Participant Characteristics Among Black Women, by Hysterectomy Status: CARDIA Study, 2000–2002

	No Evidence or Report of Hysterectomy or Oophorectomy		Hysterectomy Only (1 or 2 Ovaries Remaining)		Hysterectomy and Bilateral Oophorectomy	
Variable	No.[a]	Mean (SD) or %	No.[a]	Mean (SD) or %	No.[a]	Mean (SD) or %
		Year 15				
Age, y	852	39.3 (3.9)	93	41.6[b] (3.2)	38	42.2[c] (3.0)
Age at menarche, y	802	12.5 (1.5)	89	12.1[b] (1.5)	37	12.4 (1.6)
Blood pressure, mm Hg						
Systolic	848	116 (16.4)	92	118 (17.0)	38	117 (13.9)
Diastolic	848	75.5 (12.6)	92	75.7 (11.7)	38	78.0 (11.5)
Highest level of education, y	847	14.2 (2.2)	93	14.0 (2.1)	38	13.7 (2.5)
Body mass index, kg/m^2	837	31.4 (8.0)	91	31.6 (7.5)	38	34.8[c] (5.6)
Waist circumference, cm	844	90.0 (16.2)	93	90.1 (13.3)	38	96.4[c] (10.6)
CES-D score	833	10.9 (8.8)	89	12.0 (9.1)	37	13.8 (10.8)
% with depressive symptoms	833	25.0	89	29.2	37	40.5[c]
Cholesterol, mg/dL						
Total cholesterol	827	179 (32.2)	91	189[b] (36.9)	37	187 (39.4)
HDL	827	54.1 (13.5)	91	54.3 (16.0)	37	54.8 (15.2)
LDL	824	108 (29.8)	91	116[b] (33.3)	37	112 (36.3)
VLDL	824	16.0 (8.6)	91	17.8 (9.4)	37	20.1 (12.5)
Triglycerides	827	82.4 (57.2)	91	89.1 (47.0)	37	100 (62.1)
Total physical activity score[d]	846	249 (235)	92	202 (205)	38	172[c] (169)
% with polycystic ovarian disease/syndrome	839	1.1	92	4.4[b]	38	13.2[c]
% ever been pregnant	850	88.0	93	91.4	38	81.6
% ever taken oral contraceptives	852	82.4	91	90.1	38	79.0
% ever smoker	852	37.4	93	43.0	38	39.5
% alcohol drinker	850	68.1	93	73.1	38	57.9
% with tubal ligation	850	35.2	93	45.2	38	39.5
% with self-reported fibroids[e]	505	29.5	89	83.2[b]	31	87.1[c]
		Year 16				
% with fibroids detected by TVUS	465	66.9	NA	NA	NA	NA
Follicle-stimulating hormone, mIU/dL	503	12.0 (14.6)	84	15.6[b] (16.8)	14	25.5 (36.8)
Luteinizing hormone, mIU/dL	503	8.3 (12.6)	84	11.3[b] (12.9)	14	12.0 (12.7)
Free testosterone, mg/dL	506	0.2 (0.2)	83	0.2 (0.1)	14	0.2 (0.1)
SHBG, mg/dL	506	26.2 (12.4)	83	25.0 (11.0)	14	27.8 (16.1)
Total testosterone, mg/dL	506	26.1 (21.6)	84	23.0 (15.5)	14	19.1 (14.5)

Notes. CARDIA = Coronary Artery Risk Development in Young Adults; CES-D = Center for Epidemiologic Studies Depression Scale; HDL = high-density lipoprotein; LDL = low-density lipoprotein; VLDL = very-low-density lipoprotein; TVUS = transvaginal ultrasound; NA = not applicable; SHBG = sex hormone–binding globulin. Measurements from the CARDIA Women's Study are denoted as "year 16."

[a]Includes only women for whom both hysterectomy and oophorectomy status were known.

[b]$P < .05$ comparing hysterectomy only versus no hysterectomy or oophorectomy.

[c]$P < .05$ comparing total hysterectomy versus no hysterectomy or oophorectomy.

[d]From the modified version of the Minnesota Leisure Time Physical Activity Questionnaire.[10]

[e]Fibroids assessed by self-report at year 15 among women with hysterectomy of any type or at year 16 among women who participated in the CARDIA Women's Study.

ultrasound examination. Analyses were cross-sectional and used combined prevalence data from years 15 and 16. All analyses were conducted with SAS version 8.2 (SAS Institute Inc, Cary, NC).

RESULTS

Sample Characteristics

Women with complete oophorectomy status data were categorized as having no evidence or report of hysterectomy, hysterectomy without oophorectomy, or hysterectomy with oophorectomy.

At the year-15 examination, when participants were aged 33 to 45 years, the prevalence

TABLE 2—Participant Characteristics Among White Women, by Hysterectomy Status: CARDIA Study, 2000–2002

	No Evidence or Report of Hysterectomy or Oophorectomy		Hysterectomy Only (1 or 2 Ovaries Remaining)		Hysterectomy and Bilateral Oophorectomy	
Variable	No.[a]	Mean (SD) or %	No.[a]	Mean (SD) or %	No.[a]	Mean (SD) or %
		Year 15				
Age, y	983	40.7 (3.4)	16	41.4 (3.8)	13	41.8 (3.2)
Age at menarche, y	963	12.8 (1.5)	16	12.1 (1.7)	13	12.4 (0.9)
Blood pressure, mm Hg						
Systolic	980	106 (11.9)	16	112 (13.2)	13	115[b] (20.5)
Diastolic	980	69.4 (9.4)	16	76.8[c] (8.5)	13	73.8 (9.0)
Highest level of education, y	981	15.8 (2.4)	16	14.9 (2.6)	13	15.7 (3.3)
Body mass index, kg/m^2	962	26.6 (6.7)	16	30.6[c] (8.7)	13	29.4 (7.6)
Waist circumference, cm	967	81.3 (14.3)	16	89.3[c] (18.9)	13	89.2[b] (17.4)
CES-D score	975	8.1 (7.5)	16	9.6 (7.1)	13	10.1 (9.0)
% with depressive symptoms	975	13.0	16	12.5	13	23.1
Cholesterol, mg/dL						
Total cholesterol	965	182 (32.0)	16	172 (38.0)	13	191 (37.7)
HDL	965	56.4 (14.9)	16	47.7[c] (12.5)	13	53.7 (13.2)
LDL	963	107 (29.1)	16	103 (33.2)	12	103 (32.8)
VLDL	963	18.3 (10.5)	16	21.1 (9.5)	12	28.9 (19.7)
Triglycerides	965	92.7 (57.1)	16	105 (47.4)	13	187 (180)
Total physical activity score[d]	978	331 (260)	16	276 (208)	13	267 (213)
% with polycystic ovarian disease/syndrome	972	2.2	16	6.3	12	8.3
% ever been pregnant	979	77.1	16	93.8	13	84.6
% ever taken oral contraceptives	983	83.7	16	68.8	13	92.3
% ever smoker	983	43.2	16	18.8[c]	13	23.1
% alcohol drinker	982	86.8	16	62.5[c]	13	61.5[b]
% with tubal ligation	983	13.3	16	18.8	13	23.1
% with self-reported fibroids[e]	502	13.9	15	60.0[c]	5	60.0[b]
		Year 16				
% with fibroids detected by TVUS	501	38.5	NA	NA	NA	NA
Follicle-stimulating hormone, mIU/dL	519	13.8 (18.9)	15	13.2 (12.2)	3	6.4[b] (2.8)
Luteinizing hormone, mIU/dL	518	8.4 (10.3)	15	7.7 (5.0)	3	3.9 (2.9)
Free testosterone, mg/dL	519	0.2 (0.6)	15	0.3 (0.2)	3	0.2 (0.2)
SHBG, mg/dL	519	31.3 (14.5)	15	25.9 (10.5)	3	24.0 (13.1)
Total testosterone, mg/dL	519	26.5 (46.8)	15	32.3 (20.1)	3	16.7 (13.2)

Notes. CARDIA = Coronary Artery Risk Development in Young Adults; CES-D = Center for Epidemiologic Studies Depression Scale; HDL = high-density lipoprotein; LDL = low-density lipoprotein; VLDL = very-low-density lipoprotein; TVUS = transvaginal ultrasound; NA = not applicable; SHBG = sex hormone–binding globulin. Measurements from the CARDIA Women's Study are denoted as "year 16."

[a]Includes only women for whom both hysterectomy and oophorectomy status were known.

[b]$P < .05$ comparing total hysterectomy versus no hysterectomy or oophorectomy.

[c]$P < .05$ comparing hysterectomy only versus no hysterectomy or oophorectomy.

[d]From the modified version of the Minnesota Leisure Time Physical Activity Questionnaire.[10]

[e]Fibroids assessed by self-report at year 15 among women with hysterectomy of any type or at year 16 among women who participated in the CARDIA Women's Study.

of hysterectomy among CARDIA women as a whole was 12% among Black women and 4% among White women.

Among those for whom oophorectomy status was known, 29% of Black women with hysterectomy also reported bilateral oophorectomy, whereas 45% of White women with hysterectomy reported bilateral oophorectomy. Black women who underwent hysterectomy without oophorectomy were on average older and had higher total and low-density lipoprotein cholesterol levels, higher follicle-stimulating hormone and luteinizing hormone levels, younger age at menarche, higher self-reported prevalence of PCOS, and higher prevalence of self-reported history of fibroids compared with Black women with no hysterectomy (Table 1). Black women who underwent hysterectomy with oophorectomy were on average older than were those with no history of hysterectomy, had a higher BMI and waist circumference, were more likely to report depressive symptoms, were less physically active, and self-reported higher prevalence of PCOS and fibroid history.

White women who underwent hysterectomy without oophorectomy had higher diastolic blood pressure, higher BMI, larger waist circumference, lower high-density lipoprotein levels, lower prevalence of smoking history, lower prevalence of alcohol use, lower prevalence of self-reported past or current use of oral contraceptives, and higher prevalence of self-reported history of fibroids compared with those with no history of hysterectomy (Table 2). Compared with those without hysterectomy, White women who underwent hysterectomy with bilateral oophorectomy had higher mean systolic blood pressure, larger waist circumference, and higher triglyceride levels; were less likely to be alcohol drinkers; and had higher prevalence of self-reported fibroid history. Because of lack of a statistical difference between groups by hysterectomy status and because of the limited number of women with oophorectomy, subsequent analyses pooled these groups. Additionally, women who were omitted from Tables 1 and 2 because of incomplete oophorectomy status data were included in the pooled analyses in Tables 3 and 4 (because hysterectomy status was known even if oophorectomy status could not be determined).

Black Versus White

Among women who underwent hysterectomy (regardless of oophorectomy status), 78% were Black, whereas only 22% were White. Table 3 compares key participant characteristics by race, pooling women with hysterectomy regardless of oophorectomy status. White women who had undergone hysterectomy with or without oophorectomy had more years of education, lower BMI, lower incidence of tubal ligation, and lower prevalence of self-reported history of fibroids and were more physically active than were Black women who had undergone a hysterectomy ($P<.05$). White women with no history of hysterectomy were on average older, reported older age at menarche, completed more years of schooling, had lower BMI and smaller waist circumference, were less likely to report depressive symptoms, had a lower percentage of smoking history and

TABLE 3—Participant Characteristics, by Hysterectomy Status and Race: CARDIA Study, 2000–2002

Variable	Hysterectomy With or Without Oophorectomy		No Hysterectomy	
	Black (n = 151–157), Mean (SD) or %	White (n = 39–41), Mean (SD) or %	Black (n = 802–852), Mean (SD) or %	White (n = 962–983), Mean (SD) or %
Age at year-15 examination, y	41.8 (3.1)	41.5 (3.7)	39.3 (3.9)	40.7[a] (3.4)
Age at menarche, y	12.2 (1.5)	12.2 (1.3)	12.5 (1.5)	12.8[a] (1.5)
Highest level of education, y	13.8 (2.4)	15.0[a] (2.9)	14.2 (2.2)	15.8[a] (2.4)
Body mass index, kg/m^2	32.6 (7.2)	29.2[a] (8.1)	31.4 (8.0)	26.6[a] (6.7)
Waist circumference, cm	92.1 (13.2)	87.5 (16.9)	90.0 (16.2)	81.3[a] (14.3)
CES-D score	12.6 (9.4)	10.5 (8.5)	10.9 (8.8)	8.1[a] (7.5)
% with depressive symptoms	33.1	19.5	25.0	13.0[a]
Total physical activity score[b]	195 (193)	301[a] (217)	249 (235)	331[a] (260)
% with polycystic ovarian disease/syndrome	5.8	7.7	1.1	2.2
% ever been pregnant	89.8	82.9	88.0	77.1[a]
% ever taken oral contraceptives	85.8	80.5	82.4	83.7
% ever smoker	43.3	34.2	37.4	43.2[a]
% alcohol drinker	66.0	63.4	68.1	86.8[a]
% with tubal ligation	46.5	24.4[a]	35.2	13.3[a]
% with self-reported fibroids[c]	85.9	68.0[a]	29.5	13.9[a]
% with fibroids detected by TVUS at year 16 examination	NA	NA	66.9	38.5[a]

Notes. CARDIA = Coronary Artery Risk Development in Young Adults; CES-D = Center for Epidemiologic Studies Depression Scale; TVUS = transvaginal ultrasound; NA = not applicable. Sample sizes vary within groups because some data on individual responses among women attending the Year 15 Cardia exam were missing.

[a]$P<.05$, comparing Black and White women with known hysterectomy status.

[b]From the modified version of the Minnesota Leisure Time Physical Activity Questionnaire.[10]

[c]Fibroids assessed by self-report at year 15 among women with hysterectomy of any type or at year 16 among women who participated in the CARDIA Women's Study.

TABLE 4—Adjusted and Unadjusted Odds Ratios (ORs) for Hysterectomy Prevalence: CARDIA Study, 2000–2002

	All Participants (n = 1863)		Women With Self-Reported or Imaged Fibroids (n = 1144)	
Variable	Unadjusted OR (95% CI)[a]	Adjusted OR (95% CI)[a]	Unadjusted OR (95% CI)[a]	Adjusted OR (95% CI)[a]
Race	3.52 (2.52, 4.90)	3.70 (2.44, 5.61)	4.00 (2.74, 5.83)	3.47 (2.23, 5.40)
Age, y	1.15 (1.10, 1.21)	1.17 (1.12, 1.23)	1.14 (1.08, 1.19)	1.15 (1.09, 1.21)
Education, y	0.84 (0.79, 0.90)	0.93 (0.86, 1.00)	0.86 (0.80, 0.92)	0.93 (0.86, 1.01)
Access to medical care	0.93 (0.55, 1.56)	0.60 (0.33, 1.10)	1.11 (0.63, 1.94)	0.72 (0.39, 1.36)
BMI, kg/m^2	1.05 (1.03, 1.06)	1.01 (0.99, 1.04)	1.04 (1.02, 1.06)	1.01 (0.98, 1.03)
Polycystic ovarian disease/syndrome	3.90 (1.96, 7.74)	5.37 (2.41, 12.0)	3.41 (1.64, 7.11)	4.43 (1.89, 10.39)
Tubal ligation	2.36 (1.74, 3.19)	1.30 (0.92, 1.86)	2.18 (1.57, 3.02)	1.31 (0.91, 1.90)
Depressive symptoms	1.90 (1.37, 2.65)	1.43 (0.97, 2.11)	1.79 (1.26, 2.55)	1.38 (0.92, 2.08)
Age at menarche, y	0.81 (0.73, 0.89)	0.85 (0.76, 0.95)	0.81 (0.73, 0.91)	0.83 (0.74, 0.94)
Geographic site				
Birmingham	2.48 (1.73, 3.55)	2.66 (1.73, 4.09)	2.72 (1.79, 4.12)	2.65 (1.69, 4.16)
Chicago	0.79 (0.50, 1.25)	0.87 (0.51, 1.49)	0.94 (0.57, 1.56)	0.82 (0.47, 1.44)
Minneapolis	1.06 (0.71, 1.59)	1.18 (0.72, 1.94)	1.33 (0.83, 2.14)	1.57 (0.93, 2.65)
Oakland (Ref)	1.00	1.00	1.00	1.00
Fibroids[b]	NA	NA	1.59 (1.15, 2.19)	1.12 (0.78, 1.62)

Notes: CARDIA = Coronary Artery Risk Development in Young Adults; CI = confidence interval; BMI = body mass index; NA = not applicable.
[a]White is the reference category.
[b]Fibroids assessed by self-report at year 15 among women with hysterectomy of any type, self-reported ever history at year 16 among women who participated in the CARDIA Women's Study, or fibroids visualized by transvaginal ultrasound at year 16 among women who participated in the CARDIA Women's Study.

prior pregnancy, were more likely to drink alcohol at least occasionally, were more physically active, and had lower prevalence of fibroids and self-reported tubal ligation history.

Race and Hysterectomy

Eight hundred fifty-two Black women and 983 White women had no report or evidence of hysterectomy; these women served as the reference group for odds ratio (OR) calculations. As presented in Table 4, the unadjusted odds of hysterectomy were 3.52 times higher among Black women compared with White women (OR=3.52; 95% confidence interval [CI]=2.52, 4.90). In 1863 CARDIA women with data available for all characteristics in the model, 180 women had hysterectomies. Other significant predictors that contributed to the odds of hysterectomy were age, PCOS, and geographic site. Adjusting for all variables simultaneously slightly increased the association between race and hysterectomy, with Black women at almost 4-times-higher odds of hysterectomy compared with White women (OR=3.70; 95% CI=2.44, 5.61). Excluding women with what may be considered "essential" hysterectomy (participants noting cancer diagnosis, abnormal Papanicolaou test, or pregnancy complications at the time of hysterectomy; n=38) did not materially alter the ORs (data not shown).

Fibroid information was collected in a subset of 1144 CARDIA participants who self-reported history of fibroids at year 15 or attended the CWS (year-16) examination (19 of the 1163 women in CWS were excluded because of missing data on 1 or more characteristics in the model). Fibroid history was determined by self-report at the time of hysterectomy (positive response when asked if she had been told that she had fibroids when she had her hysterectomy), at year 16 for CWS (positive response when asked if she had ever been told that she had uterine fibroids), or fibroids imaged by ultrasound at year 16; 67% of Black women and 39% of White women had evidence of fibroids. Fibroid volumes ranged from 0.01 cm^3 to 293.8 cm^3; mean volume did not differ significantly by race (t_{487}=1.58; $P > .05$). As a secondary analysis, we considered the importance of racial differences in fibroid history prevalence. In this subset with evidence of fibroids, Black women had 4 times the odds of hysterectomy; the association was minimally attenuated in multivariable analyses (OR=3.47; 95% CI=2.23, 5.40). The fibroids themselves were associated with increased odds of hysterectomy in unadjusted analyses (OR=1.59; 95% CI=1.15, 2.19), but the OR became nonsignificant when analyses were adjusted for all other covariates (OR=1.12; 95% CI=0.78, 1.62).

The association between race and hysterectomy was not modified by education, BMI, depressive symptoms, fibroids, or geographic site. For completeness, we also explored the independent associations of additional items related to those formally evaluated in the main analysis: self-reported ability to pay for perceived needed medical care, parity, oral contraceptive use, menstrual cycle changes associated with middle age, and menstrual flow intensity and duration. None of these characteristics significantly altered OR estimates or helped to explain observed racial differences.

DISCUSSION

In this large, population-based sample of US women, hysterectomy prevalence differed markedly by race. After we adjusted for factors believed to contribute to racial differences (age, age at menarche, education, access to medical

care, BMI, PCOS, tubal ligation, depressive symptoms, and geographic location), the odds of hysterectomy among Black compared with White participants were almost 4 times higher. Moreover, past studies have asserted that fibroid prevalence tends to be higher among Black women and that fibroids also tend to be larger in volume when clinically identified,[2,12–14] suggesting that this may partially explain why Black women undergo hysterectomy more frequently. However, in the subset of women with fibroids assessed, findings were similar; the adjusted OR was only slightly attenuated. Among women who participated in CWS, 67% of Black women and 39% of White women had evidence of fibroids upon imaging, suggesting that fibroids in this particular sample were more common among Black women regardless of hysterectomy status.

Strengths and Limitations

We should note that our fibroid measurement was imperfect because fibroids were not assessed by ultrasound in all women in the CARDIA study but rather only in women enrolled in CWS and who had a uterus. Additionally, self-reported fibroid data were collected only on women in CWS as well as women in the main CARDIA study who had undergone hysterectomy. It is possible that some women with hysterectomy or without fibroids detected by ultrasound had fibroids removed that were not self-reported or that some women who had undergone hysterectomy were never told that they had fibroids. However, given the most complete data available (using both self-reported and ultrasound-detected fibroids), fibroid prevalence did not appear to be the dominant risk factor for hysterectomy prevalence.

The findings of this study are important for several reasons. First, epidemiological data have demonstrated variable differences in hysterectomy rates within and among various ethnic, cultural, geographic, and socioeconomic groups.[4] However, our understanding of the reasons for these differences is lacking. With as many as 96% of hysterectomies performed in the United States considered to be for benign conditions,[5] it is likely that individual characteristics influence hysterectomy decisions, whether it be decisions regarding treatment recommendations made by the clinician or decisions made by the patient herself (in terms of accepting or rejecting specific treatment recommendations). Our results are consistent with previous research, including the Study of Women's Health Across the Nation, which also identified socioeconomic correlates of hysterectomy status including education and geographic location.[5] After we controlled for these and additional characteristics related to hysterectomy, the association with race slightly strengthened. The factors we evaluated add to the existing body of evidence, although they failed to explain the observed racial disparity.

Because this analysis was cross-sectional (cumulative hysterectomy prevalence), we cannot infer causality or temporality, but can only hypothesize on the nature of the relationship between race and hysterectomy. In this light, we are limited by the fact that CARDIA included only 1 minority group and simply recruited participants in 2 nonspecific ethnic categories (non-Hispanic Black vs non-Hispanic White). It is unknown whether factors related to hysterectomy differ in other ethnic and racial groups not included in the study or in subgroups within those examined.

A unique strength of our study is that a significant proportion of the women were also evaluated with ultrasound, which provided the ability to verify self-reported measures of surgery history for these participants. The CARDIA study was not designed specifically to differentiate hysterectomy procedures that did or did not include bilateral oophorectomy, and therefore, these data were incomplete. We recognize that the association with participant characteristics may differ by type of hysterectomy received and whether 1 or both ovaries were preserved. Although the prevalence was small for known bilateral oophorectomy, we observed similar participant characteristics between the 2 hysterectomy groups. A larger sample of this group in future studies could allow for more-definitive evaluation of these relationships.

Conclusions

We were unable to attribute racial differences in hysterectomy to commonly measured psychosocial, socioeconomic, and other participant demographics. Because data heavily relied on self-report, we cannot rule out potential biases associated with this data collection method as well as residual confounding. However, both with and without adjustment, the odds of hysterectomy among Black women remained significantly higher than among White women; after we controlled for characteristics strongly related to racial differences, we were unable to account for the disparity in hysterectomy status by race.

We must consider the possibility that there are real biological differences that might partially explain racial differences in hysterectomy, which may include genetic heterogeneity, differences in hormone levels prior to hysterectomy, or other unmeasured clinical characteristics. However, nonclinical factors such as patient education about alternatives to hysterectomy, environmental attributes, cultural or religious beliefs, issues related to patient–provider communication, physician preference, or other psychosocial factors are likely important contributors.[15–19] Qualitative accounts of women's decisionmaking process should be considered in conjunction with these data to more fully evaluate the nature of observed racial differences.

Reasons for within- and between-population differences in hysterectomy prevalence are not well understood. Our study builds upon previous evidence that nonclinical factors play an important role in decisions to undergo hysterectomy. We found that in a population-based sample, significant racial differences in hysterectomy were observed even after we accounted for measured participant characteristics. In fact, adjustment for a wide variety of potential confounding factors minimally altered crude observed associations. These findings emphasize the need for further investigation into the practice of hysterectomy and the importance of efforts to disseminate information regarding nonhysterectomy alternatives during or prior to the decisionmaking process, particularly among minority populations. ■

About the Authors

Julie K. Bower and Pamela J. Schreiner are with the Division of Epidemiology and Community Health, University of Minnesota School of Public Health, Minneapolis. Barbara Sternfeld is with the Division of Research, Kaiser Permanente, Oakland, CA. Cora E. Lewis is with the Division of Preventive Medicine, Department of Medicine, University of Alabama, Birmingham.

Requests for reprints should be sent to Pamela J. Schreiner, Division of Epidemiology and Community Health, University of Minnesota School of Public Health, 1300 Second St S, Suite 300, Minneapolis, MN 55454 (e-mail: schre012@umn.edu).

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Contributors

J.K. Bower conducted the analyses and led the writing. P.J. Schreiner provided guidance for all analyses and served in a supervisory role for the study. All authors helped to conceptualize ideas, interpret findings, and review drafts of the article.

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Human Participant Protection

The Coronary Artery Risk Development in Young Adults study has had continuous institutional review board approval at all clinic sites since it began in 1985.

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