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Ethnic differences and predictors of colonoscopy, prostate-specific antigen, and mammography screening participation in the multiethnic cohort

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Abstract

Purpose—Given the relation between screening and improved cancer outcomes and the persistence of ethnic disparities in cancer mortality, we explored ethnic differences in colonoscopy, prostate-specific antigen (PSA), and mammography screening in the Multiethnic Cohort Study.

Methods—Logistic regression was applied to examine the influence of ethnicity as well as demographics, lifestyle factors, comorbidities, family history of cancer, and previous screening history on self-reported screening participation collected in 1999–2002.

Results—The analysis included 140,398 participants who identified as white, African American, Native Hawaiian, Japanese American, US born-Latino, or Mexican born-Latino. The screening prevalences overall were mammography: 88% of women, PSA: 45% of men, and colonoscopy: 35% of men and women. All minority groups reported 10–40% lower screening utilization than whites, but Mexican-born Latinos and Native Hawaiian were lowest. Men were nearly twice as likely to have a colonoscopy (OR = 1.94, 95% CI = 1.89–1.99) as women. A personal screening history, presence of comorbidities, and family history of cancer predicted higher screening utilization across modalities, but to different degrees across ethnic groups.

Conclusions—This study confirms previously reported sex differences in colorectal cancer screening and ethnic disparities in screening participation. The findings suggest it may be useful to include personal screening history and family history of cancer into counseling patients about screening participation.

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Conflict of interest

The authors of this paper have no conflicts of interest to report.

Keywords

Mammogram; PSA; Colonoscopy; Cancer screening; Ethnic differences

1. Introduction

Colorectal cancer is the second leading cause of cancer-related deaths in the United States (US) [1] while prostate and breast cancer are the two most commonly diagnosed sex-specific cancers [1]. The first screening guidelines for these cancers were published in 1980 [2], but with updates over time, recommendations for tests such as prostate-specific antigen (PSA) have changed in popularity [3,4]. Effective screening modalities improve cancer outcomes through earlier detection of tumors [5]; however, persistent ethnic disparities in cancer morbidity and mortality require a better understanding of factors influencing screening uptake [6].

Although colorectal cancer screening has increased over time, 37% of the US population aged 50–75 years report not being screened with lower screening utilization in some groups [7]. Women are less likely to be screened than men, and African Americans, Latinos, and Korean Americans have lower utilization rates than whites [8–10]. In 2008, 44% of men 50 years of age and older reported having had a PSA test in the last year [3]. As with colorectal cancer screening, lower rates of PSA screening were noted in African Americans, Latinos, and some Asian groups [11–13]. In 2010, 72% of women ages 50–74 reported having a mammogram in the past 2 years with the lowest rates occurring among Asian American women (64%) [14]. Cancer screening research that uses a more refined ethnic classification for groups that tend to be aggregated, such as Asian Americans, Pacific Islanders, and Latinos, is needed [10,15].

Family and personal medical history, access to medical care, and physician recommendations for cancer screening have all been shown to affect screening behaviors [8,11,13,16–21]. Interactions between ethnicity and these factors have emerged as areas of interest [13,22–25]. The purpose of the current study was to examine how ethnicity and other factors influence colonoscopy, PSA, and mammography screening among participants of the Multiethnic Cohort (MEC).

2. Patients and methods

2.1. Study population

The MEC is an ethnically diverse prospective cohort designed to investigate the association of lifestyle and genetic factors with cancer incidence. The design and implementation of the MEC have been described elsewhere [26]. Briefly, over 215,000 men and women aged 45–75 years at recruitment and residing in Hawaii or California (primarily Los Angeles County) were enrolled between 1993 and 1996. To obtain a multiethnic sample of whites, African Americans, Native Hawaiians, Japanese Americans, and Latinos, a population-based sampling frame utilized drivers' license files, supplemented with voter registration lists and Health Care Financing Administration (Medicare) files. The Institutional Review Boards at

the University of Hawaii and the University of Southern California approved the study protocol.

2.2. Data collection

At cohort entry, participants completed a self-administered, 26-page baseline questionnaire ($Q \times 1$) providing demographic, dietary, and other health and lifestyle information. Between 1999 and 2002, about 85% of eligible MEC members completed a brief follow-up questionnaire ($Q \times 2$) that included information on medical history and an expanded cancer screening practices section for men and women (mammogram, Pap smear, PSA test, colonoscopy, gastroscopy).

2.3. Exclusion criteria

Participants were excluded from the current analysis if they were not from one of the five major ethnic groups ($n = 10,311$), were <50 years of age at time of $Q \times 2$ ($n = 675$), reported a previous cancer diagnosis in $Q \times 2$ ($n = 16,568$), and did not complete $Q \times 2$ ($n = 47,879$). The final analytic sample included 140,398 participants ($n = 62,005$ men; $n = 78,393$ women) with complete data on screening history and ethnicity.

2.4. Measures

Information on ethnicity, education, and smoking was obtained from $Q \times 1$ as it was not updated in $Q \times 2$. Ethnicity was based on self-report; persons who reported mixed ancestry were assigned to one of the ethnic groups according to the priority ranking: African-American, Native Hawaiian, Latino, Japanese American, and white [26]. Latinos were split into US and Mexican born individuals. Education was coded as completing vocational school or some college (yes/no). Cigarette smoking was classified as current or not (including former and never). Information on cancer screening, age, anthropometric measures, comorbidity, and family history of cancer was obtained from $Q \times 2$. Screening prevalences were assessed using participants' reports of at least one of the following tests in the past: colonoscopy or sigmoidoscopy of the colon (colonoscopy) (yes/no), PSA (men only) (yes/no), or mammogram (women only) (yes/no). Personal screening history was defined as use of one of the other screening modalities. Screening information collected on $Q \times 1$ was not considered as it was limited to women. Age was coded as 65 years and older to provide an indicator of likely Medicare enrollment. Self-reported height and weight were used to calculate body mass index (BMI) and classified as underweight ($<18.5 \text{ kg/m}^2$), normal weight ($18.5\text{--}24.9 \text{ kg/m}^2$), overweight ($25\text{--}29.9 \text{ kg/m}^2$) and obese ($\geq 30 \text{ kg/m}^2$). The presence of comorbidity was based on participants' reporting being told by a doctor that they had at least one of the following conditions: angina pectoris, diabetes, heart disease, high blood pressure, or stroke. Family history of cancer assessed the following cancers in the participant's natural father, mother, or full siblings: colon/rectal, prostate, breast, lung, stomach, ovarian, and melanoma of the skin.

2.5. Statistical analysis

Odds ratios (OR) and 95% confidence intervals (CIs) were the primary statistics of interest, as well as predicted prevalences using the distribution of covariates for the overall MEC

population. Adjusted prevalences were obtained for each screening modality by logistic regression adjusted for age at follow-up and covariates of interest. Unconditional logistic regression was used to model screening participation for each modality. Covariates in the regression models included: ethnicity, sex, age at follow-up, education, smoking status, BMI status, location (Hawaii/Los Angeles), history of other cancer screening (personal screening history), comorbidity, previous cancer diagnosis, and family history of cancer. Sex differences by ethnicity were assessed using a Wald test of an interaction term in the regression model for colonoscopy. Differences in the effect of comorbidity, previous cancer diagnosis, and family history of cancer by ethnicity were also assessed using Wald tests of interaction terms in the regression models for colonoscopy, PSA and mammography. All analyses were conducted in SAS 9.3 (SAS Institute), using two-tailed tests with significance set at $p < 0.05$.

3. Results

Colonoscopy use was reported by 48,718 (35%) of the 140,398 participants, PSA by 27,716 (45%) of the 62,005 men, and mammography by 68,594 (88%) of the 78,393 women (unadjusted prevalences) (Table 1). After full adjustment (Table 1), the highest prevalences for colonoscopy were seen in Japanese Americans and whites (37% each), followed by African Americans (34%), US born-Latinos (32%), and Native Hawaiians (31%), while Mexican born-Latinos were lowest (27%). African American men had the highest adjusted prevalence for PSA testing (52%) and Native Hawaiian and Mexican-born Latino men the lowest (36% each). For mammography, participation was very similar (>84%) across ethnic groups with white and Japanese American women reporting the highest adjusted prevalences (89% and 88%, respectively).

Across screening modalities, participants who were white and had more years of education reported higher screening participation (Table 2). The ORs were particularly low for Native Hawaiians (colonoscopy: 0.67, PSA: 0.51, mammogram: 0.63) and Mexican born-Latinos (colonoscopy: 0.61, PSA: 0.73). Current smokers were less likely to be screened compared to former or those who never smoked. The same was true for underweight and obese individuals compared to normal weight individuals. A personal screening history was associated with a 3-fold higher prevalence of all screening while having comorbidities was associated with a 16–61% higher prevalence of screening. A family history of cancer was more important in predicting colonoscopy (OR = 1.90, 95% CI = 1.83–1.98) and PSA testing (OR = 1.79, 95% CI = 1.68–1.92) than mammography (OR = 1.45, 95% CI = 1.34–1.57).

Men reported a higher prevalence of colonoscopy (38%) than women (33%), and the interaction term between sex and ethnicity was highly significant (Table 3). When stratified by ethnicity, Native Hawaiians showed the largest sex difference (OR = 2.45, 95% CI = 2.18–2.77), but the odds were also 57–200% higher among men in the other ethnic groups. For all screening modalities, ethnicity significantly interacted with personal screening history (colonoscopy and mammogram: $p < 0.0001$, PSA: $p = 0.002$), and the risk estimates were highest for African Americans and Native Hawaiians. Ethnicity also significantly interacted with comorbidity for colonoscopy ($p = 0.01$) and mammography ($p = 0.0003$).

Only for PSA testing, ethnicity interacted with family history ($p = 0.02$); the associations were weak for all ethnic groups except African Americans (OR = 2.09, 95% CI = 1.73–2.54) and US born-Latinos (OR = 2.10, 95% CI = 1.74–2.53).

4. Discussion

This study examined colonoscopy, PSA, and mammography screening prevalences within the MEC to determine ethnic differences and predictors of screening participation in a multiethnic population. Mammography screening was high among women at 88% and PSA screening was reported by 45% of men, while only 35% of participants reported a colonoscopy. More men than women reported a colonoscopy, and screening use varied by ethnicity with the lowest rates among Mexican born-Latinos and Native Hawaiians. Personal screening history, comorbidity, and family history of cancer predicted higher screening participation across modalities but not to the same degree across ethnic groups.

Although the data for these analyses were collected in the late 1990s, the ethnic differences and the major predictors remain relevant today. A comparison of the American Cancer Society screening recommendations in 1991 and 2010 show a small change in sigmoidoscopy recommendations (3–5 years compared to every 5 years), the addition of a colonoscopy recommendation, the same mammogram recommendation (annual for women over 50), and similar PSA recommendations (no recommendation compared to guidance on informed decision making) [2,3].

We found that all ethnic groups had lower screening prevalences compared with whites, but in contrast to previous reports screening participation was relatively high for African Americans [8,9,12,13]. The primary finding was the low screening use among Mexican born-Latinos and Native Hawaiians. Two past studies, one based on $Q \times 1$ and one on $Q \times 2$, assessed the prevalence of annual and biennial mammography in the MEC and found a lower frequency of regular use among African Americans, Latinas, and Native Hawaiian women [27,28]. The lower screening use among Native Hawaiians in the current report is of particular concern given their high incidence rates for breast cancer [29] and their high percentage of late stage diagnosis for colorectal (55%), prostate (10%), and breast (37%) cancer [29].

Access to a physician and having a physician recommend screenings are important predictors of screening behavior [8,9,12,13,22]. Due to age and insurance laws in Hawaii, our population most likely had access to health care. However, our questionnaire did not ask about physician recommendations; instead, we used the presence of comorbidities that would potentially increase an individual's likelihood of visiting a physician (*i.e.*, history of angina, diabetes, hypertension, heart disease) as a proxy measure. When stratified by ethnicity, the influence of comorbidity was positive for all ethnic groups across screening modalities, which is similar to past studies although these have looked primarily at PSA screening [12,13]. In this study, the influence was lowest for white women and mammography followed by colonoscopy and African Americans. Perceptions of cancer risk may be lower among African Americans and other ethnic minority groups [30]. Discussion

of risk by a physician and awareness of one's family history of cancer may raise awareness related to personal risk and increase screening [30,31].

Research on the influence of family history of cancer and screening behavior within ethnically diverse populations has been less consistent than would be expected given the connection between family history and personal cancer risk [13,32–36]. We found that participants with a family history of cancer were nearly twice as likely to report screening use, but this association was most pronounced in African Americans and US born-Latinos. This finding is expected for PSA, given the high rates of prostate cancer within African American families; however, past studies have found that African Americans may be less likely to receive a PSA test despite a family history of prostate cancer [13,36]. Also, individuals from ethnic minorities who have a family history of cancer may be less likely to pursue other screening modalities [22,34,36], possibly because there may be less conversation around cancer diagnoses due to cultural stigmas and taboos [15]. Given recommendations that support informed decision making over the general use of PSA testing in the prevention of prostate cancer [37], it is important for individuals and physicians to discuss family history in relation to PSA testing [38]. Our findings support the importance of including family history as part of all cancer screening conversations between family members as well as between patients and physicians.

In addition to physician exposure and family history, our analysis shows that having a history of colonoscopy, PSA, or mammogram was indicative of having another sex-appropriate screening test. This agrees with previous research showing an interactive effect [23,25,39,40]. This was especially true for Japanese American women reporting a mammogram and for African Americans and Native Hawaiians across screening modalities. Higher colonoscopy use in men compared to women was most pronounced among Native Hawaiians. This finding confirms other studies reporting lower colonoscopy rates among women, although reasons for this are not well understood [9,39,41]. For Native Hawaiians, colorectal cancer incidence rates have traditionally been low [29], perhaps impacting perceived risk and the need for screening. Another potential reason for lower prevalences of colonoscopy may be due to the fear of invasiveness or anxiety of the colonoscopy procedure [42,43]. As one possible strategy, it may be effective for physicians to communicate with their patients about all age and gender relevant screenings instead of promoting one particular test at a time.

Limitations of this study include the use of self-reported data to assess screening prevalences. Therefore, a small percentage of reported testing may have been conducted in the context of diagnosis or due to symptoms and not as screening tests. Removing individuals with a previous history of cancer from the analytic sample reduced the potential for diagnostic testing to be included in our reported screening prevalences. A meta-analysis of validation studies found ethnic minority populations may overestimate screening by mammogram and men may underreport screening by PSA, but the validity of results was found to differ by study [44]. Another study of self-reported colorectal cancer screenings found them to be reliable and not influenced by age, ethnicity, sex, or family history when compared to medical records [45]. While fecal occult blood testing has been recommended as a screening test for colorectal cancer [3], use of this test was not asked on the

questionnaire and so we are not able to assess its prevalence. On the other hand, a major strength of this report is its population-based design and the inclusion of large samples from ethnically diverse populations completing the same questionnaires. Most studies of screening participation have been conducted with white, African American, and Latino populations [22,25,34,46,47], which are part of the MEC along with Japanese Americans and Native Hawaiians.

The current analysis confirmed higher colonoscopy rates in men than women and the existence of ethnic differences in colonoscopy, PSA, and mammogram screening utilization, particularly among Native Hawaiians and Mexican born-Latinos. The associations of comorbidity, family history of cancer, and personal screening history with higher screening use suggest that it may be useful to include these factors into counseling patients about screening participation.

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Table 1

Demographics and screening uptake by ethnicity in the Multiethnic Cohort Study.^a

Characteristics	All	White	African American	Native Hawaiian	Japanese American	US Born-Latino	Mexican Born-Latino
N (Male/female)	140,398 (62,005/78,393)	35,628 (16,335/19,293)	20,940 (6,827/14,113)	9,912 (4,347/5,565)	44,025 (20,662/23,363)	16,105 (7,502/8,603)	13,788 (6,332/7,456)
Age at baseline (years) ^b	59.3 (8.7)	58.1 (8.8)	60.6 (9.0)	56.2 (8.2)	60.3 (9.0)	60.2 (7.6)	58.2 (7.4)
Age at follow-up							
Under 65 years old	46.9	53.7	40.0	62.5	41.9	39.9	52.5
65 years and older	53.1	46.3	60.0	37.6	58.2	60.1	47.6
Some college education or more	57.6	74.6	60.7	48.6	61.5	40.5	23.5
Current smoker	14.6	15.2	20.0	21.2	11.4	13.8	11.7
Body mass index (kg/m ²)							
Underweight (<18.5)	1.7	1.5	0.8	0.7	3.2	0.5	0.7
Normal (18.5–24.9)	40.1	44.4	24.2	25.2	56.0	27.7	27.3
Overweight (25–29.9)	38.0	36.4	40.0	37.8	32.8	44.6	48.5
Obese (≥ 30)	19.2	17.3	31.7	35.6	7.2	27.0	22.1
Missing	1.0	0.3	3.4	0.7	0.8	0.2	1.4
Location							
Hawaii	51.1	72.4	1.9	98.8	78.8	6.6	0.4
Los Angeles	48.9	27.6	98.1	1.2	21.2	93.4	99.6
Comorbidity ^c	49.0	38.0	65.6	54.4	48.8	52.3	44.6
Family history of cancer							
Polyps	4.2	5.1	2.6	3.4	5.7	3.1	1.4
Colorectal cancer	8.9	9.4	8.5	7.5	11.2	7.4	3.2
Prostate cancer	7.0	8.2	8.9	5.4	6.3	6.9	4.4
Breast cancer	10.1	12.0	9.6	12.3	10.2	9.5	5.1
Screening prevalences, unadjusted							
Colonoscopy	34.7	38.8	35.7	24.9	38.1	32.5	21.6
PSA	44.7	50.9	50.3	28.7	42.6	47.0	38.5
Mammogram	87.5	89.6	86.6	84.3	87.9	86.5	85.5
Screening prevalences, adjusted ^d							

Characteristics	All	White	African American	Native Hawaiian	Japanese American	US Born-Latino	Mexican Born-Latino
Colonoscopy		37.0	34.0	31.0	37.4	32.3	27.2
PSA		48.7	52.1	36.1	43.7	44.8	36.0
Mammogram		88.5	87.5	87.5	88.1	85.9	84.4

^a All figures are percentages, unless otherwise noted.

^b Mean (standard deviation).

^c Comorbidity included the following: angina, diabetes, heart disease, and high blood pressure.

^d Adjusted prevalences were obtained by logistic regression models adjusted for age at follow-up, education, smoking status, BMI, location, history of other cancer screening, comorbidity, and family history of cancer.

Table 2

Odds ratios and 95% confidence intervals for determinants of colonoscopy, PSA, and mammography screening within the Multiethnic Cohort 1999–2002.

	N	Colonoscopy	P	N	PSA	P	N	Mammogram	P
Ethnicity									
White	35,628	1.00 (Ref)		16,335	1.00 (Ref)		19,293	1.00 (Ref)	
African American	20,940	0.99 (0.95–1.04)	0.77	6827	0.87 (0.80–0.93)	<0001	14,113	0.84 (0.77–0.91)	<0001
Native Hawaiian	9912	0.67 (0.63–0.70)	<0001	4347	0.51 (0.47–0.55)	<0001	5565	0.63 (0.58–0.70)	<0001
Japanese	44,025	0.98 (0.95–1.01)	0.11	20,662	0.67 (0.64–0.70)	<0001	23,363	0.84 (0.79–0.90)	<0001
US Born-Latino	16,105	0.89 (0.85–0.93)	<0001	7502	0.79 (0.73–0.84)	<0001	8603	0.94 (0.86–1.02)	0.14
Mexican Born-Latino	13,788	0.61 (0.58–0.64)	<0001	6332	0.73 (0.67–0.78)	<0001	7456	0.98 (0.89–1.07)	0.59
Male ^a	62,005	1.94 (1.89–1.99)	<0001	–	–	<0001	–	–	<0001
65 years and older	74,606	1.38 (1.35–1.41)	<0001	32,949	1.61 (1.56–1.67)	<0001	41,657	0.72 (0.68–0.75)	<0001
Some vs. no college	80,922	1.47 (1.43–1.51)	<0001	38,031	1.36 (1.31–1.42)	<0001	42,891	1.34 (1.27–1.40)	<0001
Current vs. past/never smoker	20,557	0.72 (0.70–0.75)	<0001	10,194	0.65 (0.62–0.68)	<0001	10,363	0.69 (0.65–0.73)	<0001
Body mass index (kg/m ²)									
Underweight (<18.5)	2378	0.93 (0.85–1.02)	0.14	345	0.89 (0.71–1.12)	0.31	2033	0.73 (0.64–0.82)	<0001
Normal (18.5–24.9)	56,271	1.00 (ref)		21,803	1.00 (ref)		34,468	1.00 (ref)	
Overweight (25–29.9)	53,396	0.99 (0.96–1.02)	0.41	29,035	0.98 (0.94–1.02)	0.25	24,361	1.02 (0.97–1.08)	0.47
Obese (≥30)	26,892	0.91 (0.88–0.94)	<0001	10,503	0.86 (0.82–0.91)	<0001	16,389	0.95 (0.89–1.01)	0.09
Located in Hawaii	71,785	1.07 (1.03–1.11)	<0001	34,040	0.80 (0.76–0.84)	<0001	40,648	1.25 (1.17–1.33)	<0001
Personal screening history	96,313	2.92 (2.83–3.00)	<0001	23,227	2.97 (2.87–3.08)	<0001	25,552	3.04 (2.86–3.22)	<0001
Comorbidity ^b	76,985	1.16 (1.13–1.19)	<0001	37,617	1.28 (1.24–1.33)	<0001	39,368	1.61 (1.53–1.68)	<0001
Family history of cancer									
Polyps	5909	2.01 (1.90–2.12)	<0001	–	–		–	–	
Colorectal cancer	12,451	1.90 (1.83–1.98)	<0001	–	–		–	–	
Prostate cancer	–	–		4304	1.79 (1.68–1.92)	<0001	–	–	
Breast cancer	–	–		–	–		8786	1.45 (1.34–1.57)	<0001

^aRegression by gender is not available for these screenings as PSA applies only to males and mammogram only to females.

^bComorbidity included the following: angina, diabetes, heart disease, and high blood pressure.

Table 3

Odds Ratios and 95% confidence intervals for determinants of colonoscopy, PSA, and mammography screening by ethnicity within the Multiethnic Cohort 1999–2002.^a

	White	African American	Native Hawaiian	Japanese American	US born-Latino	Mexican born-Latino	P-value ^c
Colonoscopy							
Male	1.81 (1.72–1.91)	1.57 (1.46–1.68)	2.45 (2.18–2.77)	2.03 (1.94–2.13)	1.66 (1.53–1.79)	1.61 (1.46–1.77)	<.0001
Personal screening history	2.54 (2.40–2.69)	3.14 (2.89–3.41)	3.30 (2.91–3.74)	2.94 (2.79–3.10)	2.54 (2.33–2.77)	2.85 (2.55–3.17)	<.0001
Comorbidity ^b	1.69 (1.61–1.78)	1.34 (1.25–1.43)	1.68 (1.52–1.87)	1.64 (1.57–1.72)	1.36 (1.26–1.46)	1.46 (1.34–1.60)	0.01
Family history of polyps	1.85 (1.67–2.05)	2.36 (1.97–2.82)	2.15 (1.70–2.71)	1.95 (1.79–2.12)	1.88 (1.56–2.26)	2.13 (1.56–2.91)	0.21
Family history of colorectal cancer	2.01 (1.86–2.17)	1.66 (1.50–1.84)	1.73 (1.47–2.05)	1.92 (1.81–2.05)	1.92 (1.70–2.18)	1.81 (1.47–2.24)	0.12
PSA							
Personal screening history	2.67 (2.50–2.86)	3.17 (2.84–3.53)	3.38 (2.92–3.92)	2.88 (2.71–3.06)	2.48 (2.24–2.74)	2.78 (2.45–3.15)	0.002
Comorbidity ^b	1.82 (1.70–1.96)	1.75 (1.56–1.97)	1.52 (1.31–1.78)	1.72 (1.61–1.83)	1.92 (1.73–2.13)	1.94 (1.74–2.16)	0.77
Family history of prostate cancer	1.61 (1.43–1.82)	2.09 (1.73–2.54)	1.78 (1.33–2.38)	1.84 (1.63–2.08)	2.10 (1.74–2.53)	1.30 (1.01–1.68)	0.02
Mammography							
Personal screening history	2.37 (2.11–2.66)	3.03 (2.66–3.45)	3.22 (2.51–4.13)	3.54 (3.16–3.95)	2.74 (2.31–3.26)	3.04 (2.43–3.78)	<.0001
Comorbidity ^b	1.32 (1.19–1.47)	1.64 (1.47–1.82)	1.95 (1.67–2.29)	1.66 (1.53–1.81)	1.50 (1.32–1.71)	1.61 (1.40–1.85)	0.0003
Family history of breast cancer	1.68 (1.42–1.99)	1.16 (0.98–1.37)	1.52 (1.20–1.93)	1.48 (1.28–1.72)	1.40 (1.12–1.75)	1.62 (1.17–2.25)	0.06

^a Logistic regression models adjusted for gender, age at follow-up, education, smoking status, BMI, and region, history of other cancer screening, comorbidity, and family history of cancer when appropriate.

^b Comorbidity included the following: angina, diabetes, heart disease, and high blood pressure.

^c P-value for interaction between ethnicity and independent variable obtained by logistic regression.