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ORIGINAL PAPER

An examination of sexual orientation group patterns in mammographic and colorectal screening in a cohort of U.S. women

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Abstract
Purpose Underutilization of cancer screening has been found especially to affect socially marginalized groups. We investigated sexual orientation group patterns in breast and colorectal cancer screening adherence.
Methods Data on breast and colorectal cancer screening, sexual orientation, and sociodemographics were gathered prospectively from 1989 through 2005 from 85,759 U.S. women in the Nurses' Health Study II. Publicly available data on state-level healthcare quality and sexual-orientation-related legal protections were also gathered. Multivariable models were used to estimate sexual orientation group differences in breast and colorectal cancer screening, controlling for sociodemographics and state-level healthcare quality and legal protections for sexual minorities.
Results Receipt of a mammogram in the past 2 years was common though not universal and differed only slightly by sexual orientation: heterosexual 84 %, bisexual 79 %, and lesbian 82 %. Fewer than half of eligible women had ever received a colonoscopy or sigmoidoscopy, and rates did not differ by sexual orientation: heterosexual 39 %, bisexual 39 %, and lesbian 42 %. In fully adjusted models, state-level healthcare quality score, though not state-level legal protections for sexual minorities, was positively associated with likelihood of being screened for all women regardless of sexual orientation.
Conclusions Concerns have been raised that unequal healthcare access for sexual orientation minorities may adversely affect cancer screening. We found small disparities in mammography and none in colorectal screening, though adherence to colorectal screening recommendations was uniformly very low. Interventions are needed to increase screening in women of all sexual orientation groups, particularly in areas with poor healthcare policies.

Keywords Breast cancer · Colorectal cancer · Screening · Sexual orientation · Bisexual · Lesbian

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Introduction

Breast and colorectal cancer are two of the most common cancers affecting U.S. women. In 2007 in the United States, incidence rates of a new diagnosis of breast and colorectal cancer, respectively, were 1,204 and 397 per 1,000,000 women [1]. In addition, 228 and 141 per

1,000,000 U.S. women died of breast and colorectal cancers, respectively, in that same year [1]. Although regular screening improves early detection and treatment and potentially reduces mortality [2–5], many U.S. women are not meeting recommendations for routine screening. The American Cancer Society (ACS) recommends that women receive a mammogram once a year beginning at age 40 years [6], and, until 2009, the U.S. Preventive Services Task Force also recommended that annual mammographic screening begin at age 40 [7]. To detect colorectal polyps or cancer, ACS recommends that women and men receive a virtual colonoscopy, double contrast barium enema, or flexible sigmoidoscopy every five years or a colonoscopy every 10 years beginning at age 50 years [6]. Recent data from the National Health Interview Survey (NHIS), a representative sample of U.S. women, indicate that only 53 % of women 40 years and older received a mammogram in the past year [8] and 67 % in the past 2 years [9], though among women aged 50–74 years, the percentage screened in the past 2 years reached 81 % [10]. The percentage of eligible women receiving regular sigmoidoscopies and/or colonoscopies is even smaller. NHIS data from 2008 show that among women aged 50 or older, 53 % have ever received a sigmoidoscopy [9], and 50 % have received either a sigmoidoscopy in the past 5 years or a colonoscopy in the past 10 years [8].

Underutilization of cancer screening has been found especially to affect socially marginalized and economically disadvantaged groups. Women with minority sexual orientation, such as lesbian and bisexual women, have been found in some studies to have lower screening rates than their heterosexual counterparts [11–13], though other studies have not found differences [14, 15]. A recent review article found the literature to be mixed as to whether there are sexual orientation group disparities in mammographic screening [16]. In a large sample of 93,311 women in the Women's Health Initiative (WHI), bisexual women aged 50–79 years were found to be slightly less likely to have received a mammogram in the past 2 years than same-aged heterosexuals (82 vs. 84 %) [11]. Similarly, in a combined sample of 12,000 women from seven U.S. surveys of sexual minority women, 73 % of women aged 40–49 years and 83 % of women aged 50–75 years who described themselves as lesbian or bisexual reported ever receiving a mammogram, compared to an estimated 87–90 % of women in U.S. general population surveys [13]. One study examining colorectal screening rates by sexual orientation using data from the 2001–2008 Massachusetts Behavioral Risk Behavior Surveillance System (BRFSS) found no difference across sexual orientation groups in women aged 50 years and older having ever received colorectal screening [15].

Disparities in breast and colorectal screening rates also have been associated with household income, ethnicity, and state of residence. Women with lower household income have lower rates of breast and colorectal screening relative to women with higher household income [10, 17, 18]. Lower rates of mammography have been found in Latina and American Indian/Alaskan Native women relative to white women [9, 10], and lower rates of colorectal screening have been found in black and Asian women relative to white women [17, 19]. Similarly, differences in health service use have been found to vary by geographic location within the United States due to the accessibility of care, state funding for health programs, and state policies on health insurance. The percentage of eligible women who received a mammogram in the past 2 years or ever received a colorectal screening varies by state. Among women aged 40 years and older, in general, those living in the Northeastern states, Florida, Minnesota, and Michigan have the highest rates of mammography in the past 2 years (range of 79–85 %) and women living in states in the South and West have the lowest rates (range 67–73 %) [18]. Among women 50 years or older, lifetime colorectal screening rates are highest along the East Coast (62–74 %), especially in the Northeast (68–74 %), and lowest in the South and some Western states (53–58 %) [17]. Because household income, ethnicity, and state of residence are known to be important determinants of screening disparities, they must be accounted for in studies of sexual orientation patterns in screening adherence.

Institutionalized discrimination against sexual minority populations varies widely by state and includes state laws banning same-sex marriage and adoption of children by same-sex couples and the absence of laws protecting sexual minorities against hate crimes or employment discrimination [20, 21]. These types of state-level institutionalized discrimination have been shown to negatively affect mental health of sexual minorities in nationally representative studies [22, 23], though it is not known whether they also affect other health indicators, such as cancer screening.

Few studies have examined sexual orientation group differences in cancer screening, particularly colorectal screening, nor have they examined whether state of residence may modify any observed sexual orientation-related screening disparities. We undertook the present study to investigate sexual orientation group differences in breast and colorectal cancer screening in a large cohort of U.S. women and to assess whether screening adherence patterns are affected by state of residence.

Method

Study sample

In 1989, a baseline questionnaire for the Nurses' Health Study (NHS) II was sent to approximately 520,000

registered nurses living in 14 of the most populous U.S. states, leading to the enrollment of 116,430 women aged 25–42 years (http://www.channing.harvard.edu/nhs/). Receipt of a completed questionnaire served as indication of informed consent for participation. Biennial questionnaires have since been sent to the cohort to gather data on disease risk factors, screening behavior, and disease incidence. Human subjects research approval was received from Brigham and Women's Hospital and Harvard School of Public Health.

Outcome measures

Mammography

Almost every NHSII questionnaire asked participants to indicate whether they have had a mammogram in the past 2 years and, if so, whether the mammogram was for routine screening or follow-up due to an abnormal finding. In 1989, the wording of this question was slightly different, asking whether participants had ever had a mammogram and, if yes, the age at first mammogram, how many years since their last mammogram, and the reason for the last mammogram.

Colonoscopy/sigmoidoscopy

An item on colorectal screening was included on each NHSII cohort questionnaire from 1991 to the present. These questions asked participants whether they had had a colonoscopy or sigmoidoscopy in the past 2 years and for what reason (routine screening or follow-up due to an abnormal finding).

Individual-level predictors

Sexual orientation

In 1995, a measure of sexual orientation identity was added to the NHSII questionnaire [24]. The item read: "Whether or not you are currently sexually active, what is your sexual orientation or identity? (Please choose one answer)" with possible responses: (1) heterosexual; (2) lesbian, gay, or homosexual; (3) bisexual; (4) none of these; (5) prefer not to answer. Our analyses included participants who described their sexual orientation identity as heterosexual; bisexual; or lesbian, gay, or homosexual.

Ethnicity

On the baseline questionnaire, women were asked to describe their ancestry choosing from a list of provided categories [25].

Socioeconomic status

Participants reported annual household income in 2001, which we then used to create five categories: less than $50,000, $50,000 to less than $75,000, $75,000 to less than $100,000, $100,000 or greater, and missing income.

State-level predictors

We used two indicators of state-level factors that were hypothesized to affect screening disparities. One was an indicator recently developed and tested by Hatzenbuehler et al. [22] representing the presence in 2005 on the state level of laws specifying sexual orientation as a protected category in hate crimes statutes and banning sexual-orientation-related employment discrimination. We created a binary variable for each U.S. state reflecting the presence or absence of these legal protections, coded 1 or 0, respectively. The second state-level variable we used was a composite measure developed in 2008 by the U.S. Agency for Healthcare Research and Quality (AHRQ) to rate the overall healthcare quality available in a state. The measure was continuous and ranged from 0 (worse than average of other states on all health indicators assessed by AHRQ) to 100 (better than average of other states on all health indicators assessed by AHRQ) [26].

Statistical analyses

To address study aims related to adherence to screening recommendations, we used all available data from study inception in 1989 though the 2005 wave of data collection. We used these data to calculate the proportion of heterosexual, bisexual, and lesbian women aged 40–60 years who had received a mammogram in the 2 years prior to a survey wave and calculated the proportion of women aged 50–60 years in each sexual orientation group who had ever received a colonoscopy or sigmoidoscopy since age 50. Women reporting a new cancer occurrence were excluded from analyses of screening behavior from that point on. State of residence is updated each questionnaire cycle, so state of residence at the time of screening report was used in analyses.

We then examined orientation group differences in adherence to mammographic screening recommendations using generalized estimating equation methods to generate prevalence ratios (PR) and 95 % confidence intervals (CI) using log-binomial regression and Poisson regression with robust error variance [27, 28] and accounting for repeated measures from participants over multiple waves of data collection using a compound symmetry working correlation matrix. Partially adjusted models controlled for age at time of screening, ethnicity, and household income. Fully

adjusted models controlled for these same covariates in addition to the two state-level covariates: presence or absence of sexual-orientation-related legal protections and mean AHRQ score for overall healthcare quality available in a participant's state of residence. We examined sexual orientation group differences in colorectal screening since age 50 years using multivariable models to estimate PR and 95 % CI. Partially adjusted models controlled for age at time of screening, ethnicity, and household income. Fully adjusted models controlled for these covariates and the two state-level covariates. In addition, we examined possible effect modification of the relationship between sexual orientation and mammographic and colorectal screening by the two state-level indicators by introducing to statistical models interaction terms between sexual orientation and state-level indicators.

Results

From age 40 to 60 years, 85,756 women from the NHSII cohort (73 % of original cohort) provided 360,264 observations included in our repeated measures analyses of mammographic screening (Table 1). From age 50 to 60 years, 32,831 women (87 % of age-eligible women from the original cohort) contributed data to cross-sectional analyses of ever receipt of colonoscopy/sigmoidoscopy during this age period (Table 2). Approximately 1 % of the cohort described themselves as lesbian or bisexual and 94 % as white, and annual household income ranged from less than $50,000 (17 %) to greater than $100,000 (35 %). Sixty-two percent ($n = 31$) of U.S. states had sexual-orientation-related protections in state law and AHRQ overall healthcare quality rating scores in the states ranged from 26 to 69 with a mean of 48 (standard deviation = 10), where lower score indicated worse overall healthcare quality in a state (not in table).

Overall, receipt of a mammogram in the past 2 years among women aged 40 and older was common though not universal and differed slightly by sexual orientation: heterosexual 84 %, bisexual 79 %, and lesbian 82 % (Table 1). Receipt of a mammogram in the past two years was similarly high across age, ethnicity, and income groups, though some disparities were observed. On the other hand, fewer than half of eligible women had ever received a colonoscopy or sigmoidoscopy during the age interval 50–60 years, and rates did not differ by sexual orientation: heterosexual 39 %, bisexual 39 %, and lesbian 42 % (Table 2). In addition, rates of colonoscopy and sigmoidoscopy were low across all age, ethnicity, and income groups and in only the older age group did more than half of women report this type of cancer screening (60 % of women aged 55–60 years).

Table 1 Individual-level sample characteristics and percent receiving mammogram in past 2 years among women participating in the Nurses' Health Study (NHS) II, aged 40–60 years ($n = 85,756$)

	Number of observations in NHSII at ages 40–60 years % (of observations)	Percent receiving mammogram in past 2 years at ages 40–60 years (of observations)
Total	# Obs. = 360,171	
Sexual orientation		
Heterosexual	98.8 (355,831)	83.6 % (297,446)
Bisexual	0.4 (1,314)	79.2 % (1,040)
Lesbian	0.8 (3,026)	82.2 % (2,486)
Age group (years)		
40–44	46.1 (165,929)	77.6 % (128,705)
45–49	33.0 (118,726)	86.9 % (103,115)
50–54	16.6 (59,860)	91.4 % (54,691)
55–60	4.4 (15,656)	92.4 % (14,461)
Ethnicity		
African American	1.5 (5,145)	83.4 % (4,291)
Asian American	1.5 (5,263)	79.3 % (4,172)
Latina	1.3 (4,615)	78.7 % (3,634)
White (non-Latina)	94.1 (334,519)	83.7 % (279,922)
Other	1.7 (6,056)	83.8 % (5,073)
Missing	1.3 (4,573)	84.9 % (3,880)
Income		
<50k	16.3 (45,204)	79.9 % (36,126)
50–75k	27.5 (76,210)	83.3 % (63,452)
75–100k	20.8 (57,823)	84.5 % (48,853)
100k+	35.5 (98,427)	86.6 % (85,238)
Missing	22.9 (82,507)	81.6 % (67,303)

Results of a set of three multivariable models for mammography are shown in Table 3. Bisexual (PR 0.94; 95 % CI 0.90, 0.98) and lesbian (PR 0.97; 95 % CI 0.95, 1.00) women were slightly less likely to have had a mammogram in the past 2 years compared to heterosexual women, and these differences were essentially unchanged when the other individual-level and state-level covariates were added to models. Differences in mammographic screening by ethnicity and household income were similarly modest. Each 10-unit elevation of state-level AHRQ healthcare quality score was associated with a 2 % higher likelihood of having had a mammogram in the past 2 years. Interaction terms between sexual orientation and state-level indicators were not statistically significant ($p > 0.05$).

Table 4 shows results of a set of three multivariable models for colonoscopy/sigmoidoscopy. No significant

Table 2 Individual-level sample characteristics and percent receiving colonoscopy or sigmoidoscopy since age 50 among women participating in NHSII, ages 50–60 years ($n = 32,831$)

	Women in NHSII at ages 50–60 years % (n)	Percent ever receiving colonoscopy/ sigmoidoscopy at ages 50–60 years % (n)
Total	$n = 32,831$	
Sexual orientation		
Heterosexual	98.7 (32,405)	39.3 % (12,747)
Bisexual	0.4 (124)	38.7 % (48)
Lesbian	0.9 (302)	42.4 % (128)
Age group (years)		
50–54	74.2 (24,373)	32.2 % (7,858)
55–60	25.8 (8,458)	59.9 % (5,065)
Ethnicity		
African American	1.6 (512)	47.7 % (244)
Asian American	1.4 (460)	44.1 % (203)
Latina	1.3 (406)	38.2 % (155)
White (non-Latina)	94.1 (30,528)	39.3 % (11,991)
Other	1.7 (539)	36.2 % (195)
Missing	1.2 (386)	35.0 % (135)
Income		
<50k	16.6 (4,283)	31.7 % (1,357)
50–75k	27.7 (7,118)	37.0 % (2,633)
75–100k	20.3 (5,232)	40.0 % (2,094)
100k+	35.4 (9,103)	46.0 % (4,191)
Missing	21.6 (7,095)	37.3 % (2,648)

differences in screening by sexual orientation or ethnicity were found with the exception of African-American women, who were almost 30 % more likely than white women to have ever received colorectal screening. Household income showed a strong positive association with likelihood of colorectal screening. Interestingly, living in a state with sexual-orientation-related legal protections was associated with 8 % higher likelihood of having received colorectal screening (age-adjusted model, Table 4), but this protective effect was completely attenuated in the fully adjusted model (Table 4). With each 10-unit elevation of state-level AHRQ healthcare quality score, likelihood of having had a colonoscopy/sigmoidoscopy increased by 9 %. Interaction terms between sexual orientation and state-level indicators were not statistically significant ($p > 0.05$).

Discussion

Breast and colorectal cancer are among the most prevalent cancers in U.S. women, and screening technologies widely available in the United States offer effective methods for early detection. Adherence to regular screening guidelines, however, falls well short of recommendations, particularly for colorectal screening. Concerns have been raised that unequal healthcare access for sexual orientation minorities may affect screening, perhaps due to actual and anticipated discrimination in healthcare settings or to inequities in health insurance coverage due to discriminatory marriage laws at the state and federal level in the United States [29]. In our large, national cohort of women, we found that mammographic screening was only slightly lower in sexual minority compared to heterosexual women. In addition, for colorectal screening, we did not find screening disparities by sexual orientation, though adherence to colorectal screening recommendations was low in women of all groups. Furthermore, we did not find evidence that the presence or absence of sexual-orientation-related protections in state laws modified associations between sexual orientation and mammographic or colorectal screening adherence.

Findings from previous studies on disparities in mammographic screening have been mixed, with some reporting rates that were several percentage points lower in sexual minority women compared to heterosexuals [11–13] and some finding no group differences [14, 15]. The only other study we are aware of that has examined colorectal screening in women by sexual orientation did not find differences, similar to our study [15]. For the NHSII cohort overall, the percent receiving a mammogram in the past 2 years (approximately 84 %) was only slightly higher than the percent (81 %) among women aged 50–74 years in a nationally representative NHIS [10]. In addition, for the NHSII cohort overall, the percent of women aged 50–60 years reporting having ever received a colonoscopy or sigmoidoscopy (approximately 40 %) was somewhat lower than the percent of women in NHIS aged 50 and older having received sigmoidoscopy in the past 5 years or colonoscopy in the past 10 years [8, 9]. In sum, though NHSII is made up of nursing professionals, we did not find evidence that mammographic or colorectal screening rates were notably higher in our cohort compared to nationally representative estimates.

We found lower rates of mammography in Latina and Asian women but not African-American women compared to white women, which is consistent with some previous research [9, 10]. We found higher rates of colorectal screening in African-American women compared to white women but no other ethnic differences. Our findings for colorectal screening are different from prior studies finding lower rates of colorectal screening in black and Asian women relative to white women [19]. Perhaps, this difference in findings is due to the composition of NHSII, which is made up of women who are current or former

Table 3 Multivariable prevalence ratios and 95 % confidence intervals of receiving mammogram in past 2 years associated with individual- and state-level characteristics in women aged 40–60 years in NHSII ($n = 85{,}756$)

	Age-adjusted models Mammogram in past 2 years at ages 40–60 years PR (95 % CI)[a]	Partially adjusted model Mammogram in past 2 years at ages 40–60 years PR (95 % CI)[b]	Fully adjusted model Mammogram in past 2 years at ages 40–60 years PR (95 % CI)[c]
Sexual orientation			
Heterosexual	Referent	Referent	Referent
Bisexual	0.94 (0.90, 0.98)	0.94(0.90, 0.98)	0.94 (0.90, 0.98)
Lesbian	0.97 (0.95, 1.00)	0.97(0.95, 1.00)	0.97 (0.95, 1.00)
Age (years)			
40–44	Referent	Referent	Referent
45–49	1.12 (1.12, 1.12)	1.12 (1.12, 1.12)	1.12 (1.12, 1.12)
50–54	1.18 (1.18, 1.18)	1.18 (1.17, 1.18)	1.18 (1.17, 1.18)
55–60	1.19 (1.19, 1.20)	1.19 (1.18, 1.20)	1.19 (1.18, 1.20)
Ethnicity			
African American	0.99 (0.98, 1.01)	1.00 (0.98, 1.02)	1.00 (0.98, 1.02)
Asian American	0.95 (0.93, 0.96)	0.95 (0.93, 0.96)	0.95 (0.93, 0.97)
Latina	0.94 (0.92, 0.96)	0.94 (0.92, 0.96)	0.95 (0.93, 0.97)
White (non-Latina)	Referent	Referent	Referent
Other	1.01 (0.99, 1.02)	1.01 (0.99, 1.03)	1.01 (0.99, 1.03)
Missing	1.02 (1.00, 1.03)	1.02 (1.00, 1.04)	1.02 (1.00, 1.04)
Income			
<50k	Referent	Referent	Referent
50–75k	1.04 (1.04, 1.05)	1.04 (1.04, 1.05)	1.04 (1.04, 1.05)
75–100k	1.06 (1.05, 1.07)	1.06 (1.05, 1.07)	1.06 (1.05, 1.07)
100k+	1.08 (1.08, 1.09)	1.08 (1.08, 1.09)	1.08 (1.08, 1.09)
Missing	1.03 (1.02, 1.03)	1.03 (1.02, 1.03)	1.02 (1.02, 1.03)
Presence of sexual-orientation-related protections in state law	1.00 (1.00, 1.01)		0.99 (0.99, 0.99)
Agency for Healthcare Research and Quality (AHRQ) overall rating for state (per 10-unit increase)	1.01 (1.01, 1.02)		1.02 (1.02, 1.02)

[a] Age-adjusted models: Prevalence ratios from separate multivariate regression models for each variable in table adjusted for age and baseline age

[b] Partially adjusted model: Prevalence ratios from multivariate regression model controlling for sexual orientation, age group, ethnicity, and income

[c] Fully adjusted model: Prevalence ratios from multivariate regression model controlling for all variables in table simultaneously

nursing professionals. As expected based on previous studies [9, 17, 18], we found a positive gradient by household income for both screening types, where higher income was associated with higher likelihood of screening. We also found higher quality state healthcare rating, as per AHRQ, to be positively associated with likelihood of a woman receiving colorectal screening. This finding suggests that despite existence of colorectal screening technologies throughout the country, a woman's state of residence strongly predicts her likelihood of benefiting from this type of life-saving technology. Given that all participants in NHSII are or were professional nurses and therefore might be relatively advantaged compared to the general population in terms of knowledge of and access to medical screening, these state-level differences are all the more disturbing.

The proportion of NHSII participants who described themselves as lesbian or bisexual make up roughly 1.2 % of the cohort, which is similar to the proportion (1.4 %) found in the WHI cohort, made up of women aged 50–79 years [11], though lower than the proportion (2.9 %) found in the representative sample of women aged 18–64 years responding the Massachusetts BRFSS survey [15]. As the Massachusetts BRFSS includes many women who are younger than those enrolled in NHSII or WHI, it is possible that these differences in proportion lesbian or bisexual represent historical cohort changes in the prevalence of sexual minority identity in U.S. women [30] or

Table 4 Multivariable prevalence ratios and 95 % confidence intervals of ever receiving colonoscopy/sigmoidoscopy associated with individual- and state-level characteristics in women aged 50–60 years in NHSII Cohort ($n = 32{,}831$)

	Age-adjusted models Ever colonoscopy/ sigmoidoscopy at ages 50–60 years PR (95 % CI)[a]	Partially adjusted model Ever colonoscopy/ sigmoidoscopy at ages 50–60 years PR (95 % CI)[b]	Fully adjusted model Ever colonoscopy/ sigmoidoscopy at ages 50–60 years PR (95 % CI)[c]
Sexual orientation			
Heterosexual	Referent	Referent	Referent
Bisexual	1.00 (0.75, 1.33)	1.02 (0.77, 1.36)	1.03 (0.78, 1.37)
Lesbian	1.10 (0.92, 1.31)	1.11 (0.93, 1.32)	1.11 (0.94, 1.33)
Age group (years)			
50–54	Ref	Ref	Ref
55–60	2.59 (2.47, 2.72)	2.57 (2.45, 2.70)	2.57 (2.45, 2.69)
Ethnicity			
African American	1.22 (1.07, 1.38)	1.25 (1.10, 1.42)	1.27 (1.12, 1.44)
Asian American	1.12 (0.98, 1.29)	1.11 (0.97, 1.27)	1.11 (0.97, 1.28)
Latina	0.96 (0.82, 1.13)	0.97 (0.83, 1.13)	0.99 (0.84, 1.16)
White (non-Latina)	Referent	Referent	Referent
Other	0.93 (0.81, 1.07)	0.94 (0.82, 1.08)	0.94 (0.82, 1.08)
Missing	0.89 (0.75, 1.05)	0.89 (0.75, 1.05)	0.89 (0.75, 1.06)
Income			
<50k,	Referent	Referent	Referent
50–75k	1.16 (1.09, 1.24)	1.16 (1.09, 1.24)	1.16 (1.08, 1.24)
75–100k	1.25 (1.17, 1.34)	1.25 (1.17, 1.34)	1.25 (1.17, 1.34)
100k+	1.42 (1.34, 1.51)	1.43 (1.34, 1.52)	1.42 (1.33, 1.50)
Missing	1.19 (1.11, 1.27)	1.19 (1.11, 1.27)	1.19 (1.11, 1.27)
Presence of sexual-orientation-related protections in state law	1.08 (1.04, 1.11)		1.00 (0.97, 1.04)
Agency for Healthcare Research and Quality (AHRQ) overall rating for state (per 10-unit increase)	1.10 (1.08, 1.12)		1.09 (1.07, 1.12)

[a] Age-adjusted models: Prevalence ratios from separate multivariate regression models for each variable in table adjusted for age and baseline age

[b] Partially adjusted model: Prevalence ratios from multivariate regression model controlling for sexual orientation, age group, ethnicity, and income

[c] Fully adjusted model: Prevalence ratios from multivariate regression model controlling for all variables in table simultaneously

discomfort among the older cohorts of women with disclosing a minority sexual orientation identity on a survey.

Our study has several limitations. Our colorectal screening analyses included only colonoscopy and sigmoidoscopy, so colorectal screening rates in the cohort may have been higher if nonendoscopic screening were also included. Data were self-reported. Because NHSII is composed predominantly of white women, and the socioeconomic range found in the cohort is narrower than in the country as a whole, generalizability may be reduced, though confounding by uncontrolled factors associated with ethnicity and socioeconomic status is also diminished. Women participating in NHSII were all registered nurses at enrollment and so may be expected to have higher rates of screening adherence than women not working in a healthcare profession. It is possible that the magnitude of sexual orientation disparities in screening could be different in a sample not made up of health professionals. Importantly, though, because all women in the cohort were registered nurses, comparisons across subgroups within the cohort are not biased by involvement in the nursing profession. In addition, sexual orientation was not a factor in recruitment into the cohort; therefore, findings are not affected by this type of enrollment bias.

Concerns have been raised that unequal healthcare access for sexual orientation minorities may adversely affect cancer screening. These concerns are well-founded given the strong evidence of actual and anticipated discrimination in healthcare settings and inequities in health insurance coverage resulting from discriminatory marriage

laws in U.S. states and in the federal government [29]. Nevertheless, we found only slight disparities across sexual orientation groups in mammography and none in colorectal screening. It is important to note, however, that rates of colorectal screening were unacceptably low in women across all groups. The absence of sexual orientation disparities in a context of universally poor utilization of potentially life-saving colorectal screening technologies is not a reassuring finding. Rather, interventions are needed to increase screening in women of all social and income groups and across all states.

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