ORIGINAL RESEARCH ARTICLE

Disparities in Breast Cancer Screening: An Analysis of Behavioral Risk Factor Surveillance Survey Data related to Racial/ Ethnic characteristics

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Keywords: mammography screening, breast cancer, race/ethnicity, sexual and gender minority, females assigned at birth

ABSTRACT

Background

Despite the death rates of breast cancer declining in the last two decades, new breast cancer cases have disproportionately affected some marginalized populations such as African American women. Since mammography screening disparities by sexual orientation and gender identity are inconsistent, it is important to understand the patterns of mammography screening to inform public health interventions.

Aims

This secondary data analysis study aimed to examine the disparities in mammography screening by sexual orientation and gender identity among females assigned at birth (FAAB) overall and stratified by race/ethnicity in the U.S.

Methods

By using 2014, 2016, and 2018 Behavioral Risk Factor Surveillance Survey (BRFSS) data, we conducted adjusted multivariable logistic regression models to estimate the odds of receiving an up-to-date mammography screening in relation to sexual orientation, gender identity, and other correlates among FAAB aged 50-74 years (unweighted N=228,257).

Results

Overall, the lifetime and up-to-date prevalence of mammography screening were 96.3% and 76.0% in U.S. FAAB, respectively. Non-Hispanic Black (NHB) participants reported a higher rate of up-to-date mammography screening (84.13%) whereas those who had an income less than $15,000 per year had the lowest (71.31%). Being insured, overweight/obese, and not a current smoker were positively associated with receiving an up-to-date mammography screening across racial and ethnic groups. Besides, being physically active was significant for an up-to-date mammography screening in non-Hispanic White (NHW) and Hispanic participants. Also, Hispanic transgender participants were more likely to have an up-to-date mammography screening than their same-ethnic cisgender counterparts.

Contribution to Evidence-Based Care

The findings reveal that the disparities in receiving an up-to-date mammography screening varied by sexual identity, gender identity, and race/ethnicity in FAAB aged 50-74 years. The lower rate of an up-to-date mammography screening was found particularly in Hispanic, bisexual AFAB. Future tailored mammogram programs should integrate physical activity and

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What do we already know about this topic?
Available evidence supports the assertion that despite the death rates of breast cancer declining in the last two decades, new breast cancer cases have disproportionately affected some marginalized populations such as people of color and immigrant populations.

What is the main contribution to Evidence-Based Practice from this article?
The findings of this quantitative study confirmed the disparities in receiving an up-to-date mammography screening existed by sexual identity, gender identity, and race/ethnicity in females assigned at birth, aged 50-74 years.

What are the main implications towards theory, practice, or policy?
Socioeconomic and behavioral factors play different roles in access to receiving an up-to-date mammography screening across races/ethnicities. The lower rate of an up-to-date mammography screening was found particularly in Hispanic, bisexual AFAB. Future tailored mammogram programs should integrate physical activity and cultural components for people with multiple minority identities.

Authors' Contributions Statement:
Both authors contributed equally to conceptualize, draft, and develop the article.

Introduction

Despite breast cancer death rates declining in the last two decades (American Cancer Society, 2020a; National Cancer Institute, 2019), new breast cancer incidences have still disproportionately affected certain subgroups, such as racial subgroups, immigrant populations, and sexual and/or gender minorities (American Cancer Society, 2020a; Amirikia, Mills, Bush, & Newman, 2011; Ooi, Martinez, & Li, 2011; Stapleton, Oseni, Bababekov, Hung, & Chang, 2018). By using the California Cancer Registry (CCR) data, Amirikia, Mills, Bush, and Newman (2011) reported that Black women aged < 44 years had higher breast cancer incidences than their non-Hispanic White (NHW) peers, and they tended to be diagnosed with stage III and IV disease in all age categories. Meanwhile, Hispanic women had higher rates of advanced stages of breast cancer than their NHW peers (Austin, Ahmad, McNally, & Stewart, 2002; Haile, John, Levine, Cortessis, Unger, Gonzales, et al., 2012; Li, & Malone, 2003).

Additionally, factors such as demographics (e.g., socioeconomics, social capital), access to care, and health literacy may affect the likelihood of mammography screening (American Cancer Society, 2020a; Ashing-Giwa, Padilla, Tejero, Kraemer, Wright, Coscarelli, et al., 2004; Lee, Ju, Vang, & Lundquist, 2010; O'Keefe, Meltzer, & Bethea, 2015). Besides, fear of cancer, fatalistic views on cancer, language, and cultural-based embarrassment contributed to a lower rate of breast cancer screening in Hispanic communities (Austin, Ahmad, McNally, & Stewart, 2002; Li & Malone, 2003). Age at diagnosis was a significant factor in young women of color (WOC); and WOC tended to have a low adherence to screening recommendations (Ooi, Martinez, & Li, 2011; Stapleton, Oseni, Bababekov, Hung, & Chang, 2018). In all, social determinants of breast cancer screening could be complicated and inter-related in WOC.

Along with the increased screening rates among U.S. women, findings regarding differences in risk factors and utilizing preventive care/mammography screening by sexual orientation and gender identity have been inconsistent. For instance, sexual minority women have an increased risk of breast cancer due to high rates of smoking, drinking, body mass index, and a lower rate of pregnancy and breastfeeding (American Cancer Society, 2020b; Polek & Hardie, 2019); however, the utilization rates showed no differences by sexual orientation (Bazzi, Whorms, King, & Potter, 2015; Solazzo, Gorman, & Denney, 2017). Agénor and her colleagues (2020) found sexual identity disparities in mammography screening by race/ethnicity. Non-Hispanic Black (NHB) lesbian women have a lower screening rate than their same-race heterosexual peers. NHW bisexual women were less likely to screen for breast cancer than their same-race heterosexual women. Still, cancer screening disparities for sexual minority WOC are under-represented (Boehmer & Elk, 2015; Malone, Snguon, Dean, Adams, & Poteat, 2019).

However, limited knowledge of mammography

screening in gender minorities was documented. A study by Narayan, Lebron-Zapata & Morris (2017) showed that an up-to-date mammography screening rate for transgender communities was equivalently high as their cisgender peers (Narayan, Lebron-Zapata & Morris, 2017). Noticeably, transgender individuals undergoing transition often receive hormone replacement therapy, placing them at uncertain risk for the development of breast cancer (Deutsch, Radix, & Wesp, 2017; Narayan, Lebron-Zapata, & Morris, 2017). Transgender men, who were females assigned at birth (FAAB), may take exogenous testosterone to induce and maintain masculine secondary sex characteristics. Androgens have also been implicated in breast cancer pathogenesis, primarily due to androgen aromatization into estrogens. In a prospective study of postmenopausal cisgender women, high serum levels of androstenedione and testosterone had associated with a relative risk for noninvasive, in situ estrogen receptor-positive breast cancer (Missmer, Eliassen, Barbieri, & Hankinson, 2004).

Since these gaps in the literature, we sought to explore mammography screening disparities overall, as well as stratified by race/ethnicity among FAAB aged 50-74 years. Using 2014, 2016, and 2018 Behavioral Risk Factor Surveillance Survey (BRFSS) data in the U.S., we further identified significant predictors concerning up-to-date mammography screening to promote equity in breast cancer prevention. It might help to develop comprehensive guidelines for breast cancer prevention and care for transgender populations (Bauer, Hammond, Travers, Kaay, Hohenadel, & Boyce, 2009; Deutsch, Radix, & Wesp, 2017).

Methods

Data

The cross-sectional survey of BRFSS used in-house interviewers, telephone call centers, or universities to collect information on health-related risk behaviors, chronic health conditions, and preventive service usage among non-institutionalized adults (aged 18 or above) living in the U.S. The BRFSS survey was conducted in English and Spanish. Response rates were 48.7% (landline) and 40.5% (cell phone) in 2014, 47.7% (landline) and 46.4% (cell phone) in 2016, and 53.3% (landline) and 43.4% (cell phone) in 2018. Institutional Board Review approval was not required as we used public-accessed data. Details of survey methods have been reported elsewhere (Centers for Disease Control and Prevention, 2019a).

Study Sample

We examined the disparities in mammography screening among FAAB aged 50-74 years; therefore, transgender individuals who were females at birth and aged 50-74 years were included in our analysis. More than 36 states asked about sexual and gender identity in their 2014, 2016, and 2018 BRFSS. This study followed the U.S. Preventive Services Task Force's (USPSTF, 2016) recommendation on biennial mammography screening for women aged 50-74 years.

Measures

Socioeconomics included age (50-54, 55-59, 60-64, 65-69, and 70-74), race/ethnicity (NHW, NHB, and Hispanic), sexual orientation (straight/heterosexual, lesbian/gay/homosexual, bisexual, and other), gender identity (cisgender and transgender), educational attainment (less than high school, graduated from high school, attended college/technical school, and graduated from college/technical school), and annual income (<$15,000, $15,000-$24,999, $25,000-$34,999, $35,000-$49,999, and $50,000 or more) and health insurance coverage (yes and no).

Health behaviors were measured using overweight/obese (yes and no), smoking status (not current smoker and current smoker), and physical activity/exercise in the past 30 days (yes and no).

Two outcome variables were as: lifetime and up-to-date mammography screening. The lifetime mammogram's question was “Have you ever had a mammogram” with responses of “yes” or “no”. Next, those who had at least one mammography screening in the past would be asked how long it has been since their last mammography screening. The responses were “within the past year”, “within the past 2 years”, “within the past 3 years”, “within the past 5 years”, and “5 or more years ago”. We dichotomized the responses into two categories for this study: up-to-date (within the past 2 years) and out-of-date (more than 2 years).

Statistical Analysis

We first ascertained the percent distribution of socioeconomics, healthcare access, health behaviors among FAAB aged 50-74 overall, as well as by gender identity and race/ethnicity separately. Next, adjusted

Wald tests were used to assess the prevalence of a mammography screening for lifetime and up-to-date by potential factors. Weighted multivariable logistic regressions were generated to examine mammography screening (lifetime and up-to-date, separately) in relation to socioeconomics and health behaviors stratified by race/ethnicity. All the logistic regressions were adjusted for age, education, and annual income. Odds ratios and 95% confidence intervals (CI) were calculated. Analyses were adjusted for the complex survey design (CDC, 2019b) using Stata 17 (College Station, TX).

Results

Descriptive Results

Table 1 presents the population estimates of descriptive characteristics among FAAB aged 50-74 overall and by race/ethnicity (unweighted N=228,257), including 79.9% (95%CI: 79.48-80.31) NHWs, 11.9% (95%CI: 11.63-12.23) NHBs, and 8.2% (95%CI: 7.84-8.52) Hispanics. We found significant racial/ethnic differences in sexual orientation, age, education, annual income, health insurance coverage, BMI, smoking status, and physical activity in socioeconomics. NHW participants tended to be older, educated, economically advanced, insured, and physically active. NHB participants were more likely to be poor, overweight/obese, a current smoker, and physically inactive compared to NHWs. Hispanic participants were more likely to be poor, overweight/obese, and physically inactive compared to NHWs.

NHW cisgender participants were more likely to be straight (p<0.001), educated (p<0.001), economically advanced (p<0.001), and physically active (p=0.0185) compared to their same-race transgender peers. NHB cisgender participants were more likely to be straight (p<0.001) and economically advanced (p=0.0043) than their same-race transgender peers. Hispanic cisgender participants were more likely to be older (p=0.0007), economically advanced (p=0.0166), and underweight/normal weight (p=0.0003) compared to their same-ethnic transgender peers.

Bivariate Results

Table 2 shows bivariate analyses of mammography screening (lifetime and up-to-date) with socioeconomics, health behaviors, and healthcare access. Overall, 96.3% (95%CI: 96.09-96.52) had lifetime mammography screening and among them, 78.9% (95%CI: 78.44-79.37) had an up-to-date mammography screening.

For lifetime mammography screening, bivariate analyses indicated that gender identity, healthcare access, overweight/obese, smoking status, and physical activity were significant factors. Transgender participants reported having had lower rate of mammography screening in the lifetime than their cisgender peers (92.4% vs. 96.4%, p=0.0118). There was no sexual orientation identity or racial/ethnic difference in lifetime mammography screening. For an up-to-date mammography screening, bivariate analyses indicated that sexual orientation, race/ethnicity, healthcare access, overweight/obese, smoking status, and physical activity were significant factors. Lesbian/gay/homosexual-identified participants had the highest prevalence of up-to-date mammography screening (79.0%), and participants with the "other" sexual orientation had the lowest (73.0%; p=0.0145). NHB participants reported higher rates of up-to-date mammography testing than their NHWs (84.1% vs. 77.8%; p<0.001). No gender identity differences in receiving an up-to-date mammography screening.

Multivariable Logistic Regression

Table 3 represented the weighted multivariable logistic regression model of receiving a mammography screening in their lifetime stratified by race/ethnicity (adjusting for age, education, and annual income). Among NHW participants ($F_{(19,108570)}$=45.51; p<0.001), transgender participants had significantly lower adjusted odds of receiving a mammography screening compared to their cisgender peers (OR: 0.40; 95%CI: 0.19-0.82; p=0.013). Besides, being insured (OR:3.26; 95%CI: 2.64-4.03; p<0.001), overweight/obese (OR:1.30; 95%CI: 1.14-1.49; p<0.001), and not a current smoker (OR:1.95; 95%CI: 1.68-2.28; p<0.001) were positively associated with receiving a mammography screening in lifetime.

Among NHB participants ($F_{(19,11189)}$=5.69; p<0.001), being insured (OR:3.12; 95%CI: 1.67-5.82; p<0.001) and overweight/obese (OR:2.03; 95%CI: 1.23-3.36; p=0.006) had greater adjusted odds of receiving a mammography screening in the lifetime.

Among Hispanic participants ($F_{(18,4036)}$=2.63; p<0.001), being bisexual (OR: 0.28; 95%CI: 0.08-1.01; p=0.051) negatively associated with a lifetime

mammography screening whereas being insured (OR:3.30; 95%CI: 1.62-6.75; p=0.001) was positively associated with a lifetime mammography screening.

Table 4 represented the weighted multivariable logistic regression model of receiving an up-to-date mammography screening stratified by race/ethnicity (adjusting for age, education, and annual income). Among NHW participants ($F_{(19,108115)}$=88.75; p<0.001), being physically inactive (OR: 0.73; 95%CI: 0.68-0.79; p<0.001) had significantly lower adjusted odds of receiving an up-to-date mammography screening. Being insured (OR:3.55; 95%CI: 3.12-4.04; p<0.001), overweight/obese (OR:1.14; 95%CI: 1.07-1.21; p<0.001), and not a current smoker (OR:1.77; 95%CI: 1.64-1.92; p<0.001) had greater adjusted odds of receiving an up-to-date mammography screening.

Among NHB participants ($F_{(19,11138)}$=5.34; p<0.001), being insured (OR:2.23; 95%CI: 1.57-3.17; p<0.001), overweight/obese (OR:1.62; 95%CI: 1.24-2.12; p<0.001), and not a current smoker (OR: 1.30; 95%CI: 1.02-1.67; p=0.036) had greater adjusted odds of receiving an up-to-date mammography screening.

Among Hispanic participants (F(19,4071)=3.10; p<0.001), being transgender (OR: 3.79; 95%CI: 0.94-15.28; p=0.061), insured (OR:2.78; 95%CI: 1.82-4.26; p<0.001), overweight/obese (OR:1.62; 95%CI: 1.24-2.12; p<0.001), and not a current smoker (OR: 1.55; 95%CI: 1.08-2.25; p=0.019) had greater adjusted odds of receiving an up-to-date mammography screening. On the contrary, being physically inactive (OR: 0.65; 95%CI: 0.48-0.90; p=0.008) had significantly lower adjusted odds of receiving an up-to-date mammography screening.

Discussion

This study is one of the few studies revealing the disparities of breast cancer screening in concerning sexual orientation and gender identity, stratified by race/ethnicity. First of all, our findings showed there is considerable heterogeneity in socioeconomics, health behaviors, and healthcare access among FAAB aged 50 to 74 between NHW, NHB, and Hispanic individuals. The trend endorses demographic diversity across racial/ethnic minority subgroups (Administration for Community Living, 2020; Kim, Jen, & Fredriksen-Goldsen, 2017). Overall, about 96.3% of FAAB participants had lifetime mammography screening and among them, 78.91% had an up-to-date mammography screening. Among all, transgender participants had a significantly lower rate of lifetime mammography screening compared to their cisgender counterparts, and this disparity is explained by the lack of health insurance, pernicious experiences in healthcare services, and historical oppression (Deutsch, Radix, & Wesp, 2017; Rahman, Li, & Moskowitz, 2019).

In our study, among those who had the lifetime mammography screening, 81.3% of transgender individuals had an up-to-date mammography screening compared to 78.9% of cisgender individuals. This prevalence is slightly higher than 74.1% in transgender populations using the BRFSS 2014 in Narayan, Lebron-Zapata, & Morris (2017). The discrepancy could be explained by an increasing tendency to include the BRFSS 2016 and 2018 data. Another postulation is the sample selection; transgender men or gender non-binary people might have a significantly lower rate of mammography screening contributing to this discrepancy. The hypothesis was addressed in Narayan, Lebron-Zapata, & Morris (2017) that transgender males were comparably likely (but not statistically significant) to undergo screening compared with transgender women, gender non-conforming, and cisgender participants. In all, our findings showed that, although transgender populations who were FAAB had a significantly lower rate of mammography screening (lifetime), the adherence was not different from their cisgender counterparts. This evidence was consistent with Narayan, Lebron-Zapata, & Morris's (2017) but not Bazzi, Whorms, King, & Potter's (2015).

Additionally, the multivariable logistic regression showed that, within NHWs, transgender individuals were less likely than their cisgender peers to adhere to the up-to-date mammography screening; however, the pattern was not presented in their Black and Hispanic counterparts. We also found that bisexual, Hispanic participants were (marginally) less likely to adhere to an up-to-date mammography test compared to their same-ethnic heterosexual counterparts. These findings are partially consistent with the findings in Bazzi, Whorms, King, & Potter (2015) that the elevated breast cancer incidence among sexual minority women has not been fully explained by differences in insurance coverage. Additional investigation is needed to elucidate why mammography services are underutilized in this population (Meads & Moore, 2013; Buchmueller & Carpenter, 2010; Cochran, Mays, Bowen, Gage, Bybee,

Roberts, et al., 2001). Although small sample sizes prevented separated subgroup analyses for people with double/triple minority identities, our finding was that sexual and gender minority individuals, especially those who were also racial/ethnic minority, are at risk of lower mammography adherence.

Since there are limited data about screening studies and practices in transgender patients (Deutsch, Radix, & Wesp, 2017; Narayan, Lebron-Zapata, & Morris, 2017), validation studies in underserved patients have found that self-reported studies tend to overestimate mammography screening adherence in underserved populations (McPhee, Nguyen, Shema, et al., 2002). We note that there are differences in some demographic characteristics by gender identity across all racial/ethnic groups. For instance, transgender individuals (who are FAAB) are younger and more financially disadvantaged compared to their cisgender counterparts in general, but no differences in health insurance coverage. Also, a consistent inference across many previous studies was that sexual/gender minority identification among younger populations is more diverse, which could be a result of increased levels of social acceptance experienced by the younger generation (Gates, 2014). There was no significant difference in health insurance coverage by gender identity in FAAB were NHW or NHB. However, health insurance coverage was marginally lower in Hispanic cisgender participants compared to their same-ethnic transgender peers (84.32% vs. 96.62%, p=0.0508). Transgender participants postponed medical care due to discrimination, extreme poverty, and unemployment (Grant et al., 2011). Compared with participants in our study, they found high proportions of survey participants with health insurance (93.78% to 93.31%; p=0.7601). The discrepancy could be explained by the marginalization and the resilience of this unique population in the historical context. People with triple or more minority identities have experienced tremendous discrimination/stigma; thus, those who were able to grow/survive from historical obsession and systematic ableism might excel better (social adaptation, resilience) than their cisgender peers and be surveyed in our study.

Limitation

The study was not without limitations. This study used cross-sectional, public access, and self-reported data from BRFSS which prevented us from exploring causational inferences. Future studies should develop longitudinal studies or interventions to examine factors that are associated with mammography screening and adherence to breast cancer screening. Meanwhile, there was a potential for under- or over-reporting of breast cancer screening (Cronin, Miglioretti, Krapcho, Yu, Geller, Carney, et al., 2009; Rauscher, Johnson, Cho, & Walk, 2008), future studies should use validated measures (e.g., medical records) for mammography screening to generate unbiased estimates of risk and utilization. Next, potential factors, such as language proficiency, acculturation, and health literacy and information, were not available in the BRFSS. Future research should include these variables to identify their roles in influencing mammography screening across and within racial/ethnic groups. Racial/ethnic subgroups, like Asians and Pacific Islanders, were not in the analyses due to the limited sample size, future studies with specific sampling methods or study designs to prevent type II errors. As a result, type II errors must be considered when examining the study's findings, as it is likely it did not possess sufficient power to detect existing effects (transgender population). Despite this limitation, the BRFSS uses a random probability sample of U.S. adults. Given that past studies have been limited to nonprobability samples (Rahman, Li, & Moskowitz, 2018), this study is the first to examine various cancer screening rates into a random sample of transgender adults.

Conclusions

This study has several significant implications for preventive care and medical professionals. The findings indicate a lower rate of adherence to cancer screening using a nonprobability sample of FAAB aged 50-74 years in the U.S., which unmet the goal of Healthy People 2020 to have 81.1% of these women receive a breast cancer screening based on the most recent guidelines (NIH, 2020). We found the relationships between a mammography screening and its correlates stratified by race/ethnicity. Our findings indicate heterogeneity of receiving mammography screening in the lifetime in relation to socioeconomics, health behaviors, and healthcare access among women within various racial/ethnic groups separately. Thus, tailored programs and practices that facilitate the utilization of

mammography screening within different racial/ethnic groups could integrate the physical activity model in preventive care programs.

Table 1. Percent distribution of socioeconomics, health behaviors, and healthcare access by gender identity, stratified by race/ethnicity among females assigned at birth (FAAB) aged 50-74 years, U.S., BRFSS 2014, 2016, & 2018.

Variable	Total	NHW		NHB		Hispanic		*p* value (by race/ethnicity)
		Cisgender	Transgender	Cisgender	Transgender	Cisgender	Transgender	
Socioeconomics								
Sexual orientation								<0.001
Straight/heterosexual	96.89	97.05	86.50	96.98	87.12	95.61	91.41	
Lesbian/gay/homosexual	1.60	**1.65**	**5.30**	1.17	2.25	1.58	2.27	
Bisexual	1.00	**0.93**	**5.44**	**1.30**	**6.35**	1.06	2.68	
Other	0.52	**0.37**	**2.76**	**0.55**	**4.28**	1.75	3.64	
Age								<0.001
50-54	24.61	23.25	25.64	28.29	16.62	32.67	13.33	
55-59	22.22	21.85	23.92	23.24	41.25	**23.85**	**67.25**	
60-64	22.49	22.66	22.52	21.53	19.51	22.33	16.92	
65-69	17.42	18.02	16.11	16.35	13.69	**13.22**	**1.85**	
70-74	13.26	14.22	11.81	10.58	8.93	**7.94**	**0.64**	
Education								<0.001
< HS	10.65	7.18	14.86	15.91	15.00	36.48	59.66	
Graduate HS	29.70	30.00	35.77	31.01	27.00	24.63	33.11	
Attended college/ technical school	31.40	31.95	31.70	32.64	34.65	24.35	3.01	
Graduate from college/ technical school	28.24	**30.86**	**17.67**	20..44	23.35	14.53	4.23	
Income								<0.001
< $15, 000	9.17	6.80	12.65	17.87	18.70	19.49	10.60	
$15,000-$24,999	14.40	12.16	18.85	22.60	18.67	24.24	16.79	
$25,000-$34,999	9.54	8.82	12.17	11.41	36.43	**13.23**	**49.45**	
$35,000-$49,999	13.54	13.50	11.63	14.12	8.60	**13.35**	**5.57**	

$50,000 or more	53.35	**58.73**	**44.70**	**34.00**	**17.60**	**29.70**	**17.59**	
Health insurance coverage								<0.001
Yes	93.78	95.17	92.92	90.93	91.91	84.32	96.62	
No	6.22	4.83	7.08	9.07	8.09	15.68	3.38	
Health behaviors								
Overweight/obese								<0.001
No	26.11	27.58	27.65	19.78	30.52	20.99	2.41	
Yes	73.9	72.42	72.35	80.22	69.48	**79.01**	**97.59**	
Smoking status								<0.001
Not current smoker	83.20	83.60	79.65	78.51	69.57	86.32	90.89	
Current smoker	16.80	16.40	20.35	21.49	30.43	13.68	9.11	
Physical activity, 30 days								<0.001
Yes, physically active	73.63	75.25	68.57	67.61	61.52	66.92	49.32	
No, physically inactive	26.37	**24.75**	**31.43**	32.39	38.48	33.08	50.68	

Notes: NHW=non-Hispanic White; NHB=non-Hispanic Black; HS=high school
All response options of "RTA/DK/NA" are excluded from the analysis
Bolded values are statistically significant at the 0.05 values.

Table 2. Weighted bivariate analyses of mammography screening and its correlates among FAAB aged 50-74, US, BRFSS 2014, 2016, & 2018.

	Ever have Mammography Screening		Up-to-Date Mammography Screening	
Variable	%	*p*	%	*p*
Total	96.31 (96.09-96.52)		78.91 (78.44-79.37)	
Socioeconomics				
Sexual orientation				
Straight/heterosexual	96.38	0.2803	78.91	**0.0145**
Lesbian/gay/homosexual	95.49		79.01	
Bisexual	94.94		77.70	
Other	94.85		72.99	
Gender identity				
Cisgender	96.36	**0.0118**	78.90	0.4531
Transgender	92.42		81.31	
Race/ethnicity				
NHW	96.27	0.5055	77.82	**<0.001**
NHB	96.61		84.13	
Hispanic	96.70		81.67	
Age				
50-54	94.61	**<0.001**	76.69	**<0.001**
55-59	95.99		77.51	
60-64	96.78		79.05	
65-69	97.42		82.03	
70-74	97.68		80.93	
Education				
< HS	93.93	**<0.0001**	73.08	**<0.001**
Graduate HS	95.28		76.52	
Attended college/technical school	96.71		78.92	
Graduate from college/technical school	97.65		83.37	
Income				
< $15, 000	93.92	**<0.001**	71.31	**<0.001**
$15,000-$24,999	94.04		71.85	
$25,000-$34,999	96.02		75.11	
$35,000-$49,999	95.94		78.30	
$50,000 or more	97.64		83.58	
Health insurance coverage				
Yes	96.85	**<0.001**	80.45	**<0.001**
No	86.78		51.59	
Health behaviors				
Overweight/obese				
No	95.60	**<0.001**	77.16	**<0.001**
Yes	96.66		79.74	
Smoking status				
Not current smoker	97.05	**<0.001**	81.45	**<0.001**
Current smoker	92.33		65.57	

Physical activity, 30 days				
Yes, physically active	96.62	**<0.001**	81.16	**<0.001**
No, physically inactive	95.47		73.01	

Notes: NHW=non-Hispanic White; NHB=non-Hispanic Black; HS=high school
All RTA/DK/NA are removed from the analysis
Bolded values are statistically significant at the 0.05 values.

Table 3. Adjusted odds of receiving mammography screening lifetime among FAAB aged 50-74 years, stratified by race/ethnicity, BRFSS 2014, 2016, & 2018.

	Ever Tested Mammography screening					
	NHW		NHB		Hispanic	
Variable	OR (95%CI)	*p*	OR (95%CI)	*p*	OR (95%CI)	*p*
Socioeconomics						
Sexual orientation						
Straight/heterosexual	REF		REF		REF	
Lesbian/gay/homosexual	0.93 (0.56-1.57)	0.800	0.30 (0.05-1.74)	0.179	empty	
Bisexual	1.33 (0.70-2.54)	0.379	0.38 (0.11-1.35)	0.134	**0.28 (0.08-1.01)**	**0.051**
Other	0.84 (0.48-1.46)	0.538	0.42 (0.07-2.54)	0.347	2.84 (0.53-15.28)	0.224
Gender identity						
Cisgender	REF		REF		REF	
Transgender	**0.40 (0.19-0.82)**	**0.013**	0.63 (0.14-2.81)	0.543	1.85 (0.34-9.92)	0.474
Age						
50-54	REF		REF		REF	
55-59	1.39 (1.18-1.65)	<0.001	1.88 (1.06-3.32)	0.030	0.84 (0.43-1.66)	0.620
60-64	1.76 (1.46-2.12)	<0.001	2.16 (1.19-3.91)	0.011	1.20 (0.55-2.60)	0.644
65-69	1.89 (1.54-2.31)	<0.001	2.36 (1.35-4.12)	0.003	1.42 (0.47-4.26)	0.532
70-74	2.20 (1.78-2.71)	<0.001	4.84 (2.65-8.84)	<0.001	1.26 (0.41-3.89)	0.691
Education						
< HS	REF		REF		REF	
Graduate HS	1.04 (0.82-1.33)	0.735	1.64 (0.90-3.02)	0.108	0.83 (0.44-1.57)	0.569
Attended college/technical school	**1.41 (1.11-1.81)**	**0.006**	**1.91 (1.00-3.62)**	**0.049**	0.99 (0.47-2.11)	0.983
Graduate from college/technical school	**1.57 (1.21-2.05)**	**0.001**	**2.71 (1.08-6.78)**	**0.033**	0.66 (0.24-1.80)	0.419
Income						
< $15, 000	REF		REF		REF	
$15,000-$24,999	0.94 (0.76-1.15)	0.548	1.07 (0.65-1.77)	0.777	0.79 (0.40-1.54)	0.486
$25,000-$34,999	1.11 (0.87-1.43)	0.396	2.84 (1.32-6.11)	0.007	2.00 (0.79-5.06)	0.144
$35,000-$49,999	1.06 (0.83-1.36)	0.617	1.99 (1.06-3.76)	0.033	0.85 (0.33-2.22)	0.744
$50,000 or more	1.90 (1.53-2.36)	<0.001	1.26 (0.61-2.61)	0.538	1.48 (0.52-4.20)	0.458
Health insurance coverage						
Yes	**3.26 (2.64-4.03)**	**<0.001**	**3.12 (1.67-5.82)**	**<0.001**	**3.30 (1.62-6.75)**	**0.001**

No	REF		REF		REF	
Health behaviors						
Overweight/obese						
No	REF		REF		REF	
Yes	**1.30 (1.14-1.49)**	**<0.001**	**2.03 (1.22-3.36)**	**0.006**	1.32 (0.70-2.50)	0.397
Smoking status						
Not current smoker	**1.95 (1.68-2.28)**	**<0.001**	1.00 (0.64-1.58)	0.991	1.40 (0.70-2.78)	0.343
Current smoker	REF		REF		REF	
Physical activity in the last 30 days						
Yes, physically active	REF		REF		REF	
No, physically inactive	0.96 (0.83-1.11)	0.584	0.92 (0.64-1.34)	0.674	0.84 (0.47-1.51)	0.557

Notes: NHW=non-Hispanic White; NHB=non-Hispanic Black; HS=high school; OR: odds ratio; CI, confidence intervals; REF=reference group.

All RTA/DK/NA are removed from the analysis

Confounding factors: age, education, and annual income

Bolded values are statistically significant at the 0.05 level.

Prevalence estimates (%) and 95% CI account for the complex survey design, which survey weights provided by the BRFSS.

Table 4. Adjusted odds of receiving up-to-date mammography screening among FAAB aged 50-74 years, stratified by race/ethnicity, BRFSS 2014, 2016, & 2018.

	Up-to-Date Mammography screening					
	NHW		NHB		Hispanic	
Variable	OR (95%CI)	*p*	OR (95%CI)	*p*	OR (95%CI)	*p*
Socioeconomics						
Sexual orientation						
Straight/heterosexual	REF		REF		REF	
Lesbian/gay/homosexual	0.96 (0.74-1.25)	0.757	0.67 (0.27-1.68)	0.391	2.34 (0.70-7.84)	0.170
Bisexual	0.80 (0.61-1.05)	0.107	0.82 (0.35-1.94)	0.658	0.62 (0.25-1.50)	0.287
Other	0.78 (0.52-1.16)	0.218	0.77 (0.31-1.93)	0.578	1.07 (0.44-2.59)	0.878
Gender identity						
Cisgender	REF		REF		REF	
Transgender	1.02 (0.67-1.54)	0.938	2.85 (0.87-9.35)	0.085	**3.79 (0.94-15.28)**	**0.061**
Age						
50-54	REF		REF		REF	
55-59	1.08 (0.99-1.18)	0.077	1.12 (0.83-1.53)	0.459	0.97 (0.66-1.42)	0.867
60-64	1.17 (1.06-1.28)	0.001	1.42 (1.06-1.90)	0.019	0.98 (0.65-1.50)	0.939
65-69	1.34 (1.22-1.47)	<0.001	1.55 (1.11-2.16)	0.010	1.22 (0.71-2.11)	0.472
70-74	1.34 (1.21-1.48)	<0.001	1.39 (0.93-2.08)	0.110	0.96 (0.52-1.76)	0.893
Education						
< HS	REF		REF		REF	
Graduate HS	1.07 (0.92-1.23)	0.396	1.33 (0.93-1.92)	0.123	0.75 (0.50-1.14)	0.178
Attended college/technical school	1.09 (0.94-1.26)	0.279	1.04 (0.70-1.54)	0.844	0.78 (0.50-1.20)	0.251
Graduate from college/technical school	1.19 (1.02-1.38)	0.030	0.92 (0.59-1.43)	0.712	0.70 (0.43-1.15)	0.163
Income						
< $15, 000	REF		REF		REF	
$15,000-$24,999	1.01 (0.90-1.14)	0.813	1.18 (0.87-1.61)	0.294	0.74 (0.49-1.10)	0.130
$25,000-$34,999	1.13 (1.00-1.29)	0.057	1.31 (0.90-1.91)	0.164	0.97 (0.56-1.68)	0.902
$35,000-$49,999	1.28 (1.13-1.45)	<0.001	1.56 (1.06-2.30)	0.025	0.85 (0.49-1.48)	0.578
$50,000 or more	1.77 (1.57-1.98)	<0.001	1.86 (1.27-2.72)	0.001	1.17 (0.75-1.84)	0.490
Health insurance coverage						
Yes	**3.55 (3.12-4.04)**	**<0.001**	**2.23 (1.57-3.17)**	**<0.001**	**2.78 (1.82-4.26)**	**<0.001**

No	REF		REF		REF	
Health behaviors						
Overweight/obese						
No	REF		REF		REF	
Yes	**1.14 (1.07-1.21)**	**<0.001**	**1.62 (1.24-2.12)**	**<0.001**	**1.48 (1.06-2.06)**	**0.020**
Smoking status						
Not current smoker	**1.77 (1.64-1.92)**	**<0.001**	**1.30 (1.02-1.67)**	**0.036**	**1.55 (1.08-2.25)**	**0.019**
Current smoker	REF		REF		REF	
Physical activity in the last 30 days						
Yes, physically active	REF		REF		REF	
No, physically inactive	**0.73 (0.68-0.79)**	**<0.001**	0.83 (0.67-1.03)	0.087	**0.65 (0.48-0.90)**	**0.008**

Notes: NHW=non-Hispanic White; NHB=non-Hispanic Black; HS=high school; REF=reference group; OR: odds ratio; CI, confidence intervals.
All RTA/DK/NA are removed from the analysis
Confounding factors: age, education, and annual income
Bolded values are statistically significant at the 0.05 level.
Prevalence estimates (%) and 95% CI account for the complex survey design, which survey weights provided by the BRFSS.

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