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Article

Breast cancer mammographic screening by different guidelines among women of different races/ethnicities

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SUMMARY

Mammographic screening is a common diagnostic tool for breast cancer among average-risk women. However, breast cancer screening guidelines differ between societies and organizations. Appropriate adherence to screening guidelines helps early diagnosis and treatment of breast cancer, which subsequently improves breast cancer survival. We used three national guidelines to define adherence recommended by US Preventive Services Task Force (USPSTF), American Cancer Society (ACS), and American College of Radiology (ACR), which included different criteria for age and frequency. (USPSTF: 50–74, biennial; ACS: 45–54, yearly, 55+ biennial; ACR: 40+, yearly) We hypothesized that adherence rates for mammographic screening may be lower among minorities (non-Hispanic black (NHB) and Hispanic/Latino) than among non-Hispanic whites (NHW) regardless of the guideline applied. We conducted a cross-sectional study using nationally representative survey data from the 2020 Health Information National Trends Survey (HINTS). Adherence to mammographic screening among NHW, NHB, and Hispanic/Latino populations were calculated. A total of 1,751 survey samples were used in the final analysis. Adherence rates of each guideline for average-risk woman in this study were as follows: USPSTF - 77.37%, ACS - 68.41%, and ACR - 57.71%. Additionally, our results demonstrated that the adherence rate was higher among NHB when compared with NHW women regardless of which guideline was applied. Multivariate logistic regression analysis indicated that both NHB ethnicity and insurance coverage exhibited strong positive associations with adherence to breast cancer screening. Our findings support other studies' results that different racial/ethnic and socio-demographic factors can affect screening adherence. Therefore, healthcare providers should promote breast cancer screening especially among NHW/Hispanic women and women lacking insurance coverage.

INTRODUCTION

Breast cancer is one of the most common cancers among females worldwide (1). In the United States, women with breast cancer have the second highest mortality rate for cancers (2). An estimated 43,700 women in the U.S. are expected to die in 2023 from breast cancer (2). Early diagnosis and management are crucial to survival for breast cancer patients. Patients receiving treatment when the cancer is localized in the early stages have a 70% higher survival rate than after the cancer has metastasized in the later stages (3, 4). Identifying breast cancer early is challenging since clinical symptoms such as weight loss, fever, and breast skin changes are not prominent in the earlier stages (5, 6). Therefore, screening is crucial for early detection and the survival of the patient.

A mammogram, which is a specialized X-ray of the breast, is a common breast cancer screening test recommended by various healthcare societies and organizations (7, 8). Different guidelines for mammogram screening have been developed and issued by different societies and organizations with varying recommendations for initial screening ages and the frequencies of screenings (**Table 1**). Unfortunately, screening adherence rates have been shown to vary between different racial/ethnic populations regardless of the use of different screening guidelines (7, 9–10). At present, there are over 20 breast cancer screening guidelines worldwide (11). In the U.S., a mammogram is recommended as the primary breast cancer screening tool for average-risk women (i.e., for screening purposes, a women is considered at average risk if she does not have a personal history of breast cancer, strong family history of breast cancer, and predisposing symptoms of developing breast cancer) by the most common guidelines (11). These guidelines are recommended and published by seven different organizations/societies (**Table 1**), including the U.S. Preventive Service Task Force (USPSTF), American Cancer Society (ACS), American College of Obstetricians and Gynecologists (ACOG), American College of Radiology (ACR), American College of Physicians (ACP), American Associate of Family Physicians (AAFP), and National Comprehensive Cancer Network (NCCN) (5, 12–18). Guidelines recommended by AAFP, ACOG, ACP, and USPSTF are similar, while those from ACS and ACR are different (13, 16). The major differences between these guidelines are the age range and frequency of mammographic screening. Previous mammographic screening studies have tended to either choose only one of the screening guidelines to perform their analyses or to make their own guidelines, which may lead to different adherence rates reported from

Table 1. Different breast cancer screening guidelines in US

Organization(s)	Start Age	End Age	Screening Intervals
US Preventative Task Force (USPSTF)/ American College of Obstetricians (ACOG)/ American College of Physicians (ACP)/ American Associate of Family Physicians (AAFP)	50	74	Once every 2 years
American College of Radiology (ACR)/ NCCN (National Comprehensive Cancer Network)	40	Life expectancy of less than 10 years	Once a year
American Cancer Society (ACS)	45	Life expectancy of less than 10 years	45–54: Once a year 55+: Once every 2 years

the same populations (19–21).

Prior research has shown that individuals who had a lower socioeconomic status (low income level, less educated, and/or rural or underserved area), poor healthcare conditions (no insurance coverage, no primary care physician, smoker, and/or history of depression or anxiety), and poor patient-provider rapport (poor patient-provider communication and/or poor understanding of care plan) tend to have lower adherence rates for mammographic screening (21–25). These factors can act independently or in combination with each other to predict lower mammogram screening adherence (21–25). In addition, certain factors may be predominant among specific racial/ethnic populations. For example, non-Hispanic black (NHB) and Hispanic/Latino tend to have lower socioeconomic status and poorer health conditions than non-Hispanic-white (NHW) populations (22, 23). However, previous studies have only analyzed one or two factors promoting an individual's mammogram screening. Therefore, a comprehensive analysis including all these common factors and specifically focused on minority populations is necessary to identify barriers and facilitators of mammogram screening.

We hypothesized that adherence rates for mammographic screening is lower among minorities (NHB and Hispanic/Latino populations) than among NHW individuals regardless of the guideline applied. In terms of adherence to mammographic screening among different populations, we defined individuals as adherent to a certain mammogram screening guideline if they followed the guideline. In addition, we also hypothesized that race/ethnicity is an independent risk factor affecting breast cancer screening adherence. Therefore, we aimed to determine differences in mammogram screening adherence rates among different populations and to identify the factors associated with higher screening adherence. In this study, we found that NHB women and women with insurance coverage had higher adherence rates than NHW women and women without insurance coverage by analyzing a national survey database. Using a nationally representative sample could cover a broad spectrum of different populations across the nation thus minimizing the population selection bias. More importantly, identifying vulnerable population and factors associated with poor mammographic adherence can help healthcare providers implement appropriate interventions to increase breast cancer screenings, which may eventually improve breast cancer early diagnosis and management among such populations.

RESULTS

General characteristics of the study population

To determine the adherence rates to different mammograph screening guidelines, we used data from a national survey to conduct this study. Health Information National Trends Survey (HINTS) is a nationally representative survey administered by the National Cancer Institute. A total of 3,865 surveys were included in the HINTS 5 Cycle 4. We excluded 1,561 men and another 100 participants with missing/unknown gender information. Furthermore, we excluded women whose age was missing/unknown (n = 31) or women younger than 40 (n = 422). Therefore, we only included 1,751 women in the final analyses (**Figure 1**).

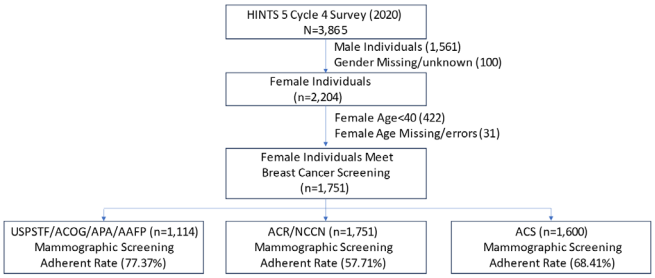

Figure 1. Study flow diagram. HINTS 5 Cycle 4 survey included a total of 3,865 participants. We only included female participants aged 40 or older. Males, ones with missing/unknown gender information, females younger than 40, and females with missing/incorrect ages were excluded, with a final 1,751 female participants aged 40 or older included in this study. Furthermore, these females were classified into three groups (USPSTF/ACOG/APA/AAFP, ACR/NCCN, and ACS) based on whether they qualified for each screening guideline (see Method section). Abbreviations: USPSTF, US Preventative Task Force; ACOG, American College of Obstetricians; ACP, American College of Physicians; AAFP, American Associate of Family Physicians; ACR, American College of Radiology; NCCN, National Comprehensive Cancer Network; ACS, American Cancer Society.

Table 2. General characteristics of the study population

Demographics	N	wt%	Health information	N	wt%	Patient-provider rapport	N	wt%
Age			*Smoking*			*Share decision making*		
40–49-year-old	151	14.41	Never	1,124	63.29	Never	31	1.72
45–49-year-old	168	14.23	Former smokers	408	22.81	Sometimes	149	9.21
50–54-year-old	164	14.53	Current smokers	188	11.92	Usually	438	24.69
55–74-year-old	950	42.29				Always	932	50.49
75 years+	318	14.53						
Race and ethnicity			*Depression / Anxiety*			*Providers make patients understand their health*		
NHW	967	60.36	Yes	483	27.56			
NHB	257	13.51	No	1,245	71.31	Never	14	0.93
Hispanic/Latino	241	10.97	*Having Regular HCP*			Sometimes	92	5.53
Others	286	15.16	Yes	1,280	70.13	Usually	404	23.01
			No	441	28.19	Always	1,048	56.91
Education level			*Insurance coverage*					
High school or below	509	30.69	No	75	5.45			
Some college	492	38.48	Yes	1,653	93.49			
College or above	696	28.75						
Marital Status			*Confidence of health*					
Single	203	14.12	Not/A little confident	88	6.56			
Married	786	57.15	Somewhat confident	414	24.08			
Others	708	26.30	Very/completely confident	1,229	68.56			
Household income			*Family history of cancer*					
< $50,000	911	46.09	No	290	16.92			
$50,000-99,999	447	27.64	Yes	1,311	75.50			
≥ $100,000	385	25.83						
Location								
Metro- or micropolitan	1,642	93.57						
Small town or rural	109	6.43						
Internet access								
Yes	1,368	17.01						
No	380	82.90						

NOTE: Total number n = 1,751 with weighted population of 86,356,317.

We found that NHW individuals made up the majority of this study (60%), and more individuals fell within the age group of 55–74 (42%) than any other age group. More individuals in the study population had regular healthcare providers than those without (70% versus 28%), and more individuals had health insurance coverage than those without (93% versus 5%). In addition, there were more individuals whose household income was less than $50,000 annually than those with higher annual household incomes (46% versus 25%; **Table 2**).

Mammogram screening adherence rates from three different screening guidelines

To determine adherence to mammogram screening from three different guidelines (USPSTF, ACR, and ACS), we analyzed mammogram screening rates from women of different age groups. Briefly, USPSTF guideline includes women aged 50–74 with mammogram done once every 2 years (same as ACP, AAFP, and ACOG guidelines, therefore we categorized these guidelines as USPSTF guideline), ACR includes women aged 40 or older with mammogram done once every year (same as NCCN, we categorized these guidelines as ACR guideline), and ACS includes women aged 45–54 with mammogram done once every year and women aged 55 or older with mammogram done once every 2 years. We found that women aged 50–54 had the highest rate of mammographic screening within 2 years when compared with other age groups (**Table 3**, $p = 0.0054$). The number of women recommended to perform mammographic screening differed between the three different screening guidelines due to differences in inclusion criteria between the three guidelines. If women were adherent to a certain screening guideline at the time when participated the survey, we considered them as "adherent" to mammographic screening under that guideline (e.g., if women aged 56 had mammograms done once in the past 2 years, then they are adherent to both USPSTF and ACS guidelines, but they are not adherent to ACR guideline). On the contrary, if women did not adhere to a certain guideline, we considered them as "not adherent" to that guideline. The mammographic screening adherence rate was higher when applying the USPSTF guidelines (77.37%) compared to the ACR (57.71%) and ACS (68.41%) guidelines, and there were statistically significant differences in the adherence rates across all three guidelines ($p < 0.001$ was

Table 3. Mammographic rates among US women of different age groups from the HINTS data

Screening status	40–44 y/o		45–49 y/o		50–54 y/o		55–74 y/o		75+ y/o	
	N	wt%	N	wt%	N	wt%	N	wt%	N	wt%
Mammogram within 2 years	100	61.84	118	70.92	124	79.04	767	76.80	187	58.72
Mammogram > 2 years ago	23	14.42	24	12.72	27	11.56	140	17.93	110	34.61
Never had a mammogram	30	21.64	22	14.30	7	2.84	19	3.39	12	4.01
Missing information	1	2.10	4	2.07	6	6.56	24	1.88	9	2.66

found in all USPSTF vs. ACR, USPSTF vs ACS, and ACR vs. ACS comparisons, **Table 4**).

Factors associated with higher adherence to mammographic screening

To determine the breast cancer screening differences among different races/ethnicities, we analyzed the mammogram screening adherence rates among four different racial/ethnic groups (NHW, NHB, Hispanic/Latino, and other). We found that racial/ethnic disparities existed in terms of adherence to mammogram screening when the ACR guideline was applied (adherence rate of 57.36% in NHW, 67.64% in NHB, 44.16% in Hispanic/Latino, and 60.03% in other racial/ethnic participants, $p < 0.05$, **Table 5**). NHB individuals had a significantly higher mammogram screening adherence rate in comparison to Hispanic/Latino individuals ($p < 0.01$), and a higher adherence rate in comparison to NHW individuals ($p = 0.05$) when the ACR guideline was applied (**Table 5**). Such findings go against our initial hypothesis that mammogram screening adherence rates would be lower among minorities.

To determine the other factors associated with adherence to mammographic screening when three different guidelines were applied, we used three multivariate logistic regressions with weighted sample analysis. We found seven factors that were positively associated with the adherence of at least one screening guideline: age, race/ethnicity, education, marital status, insurance, provider, and individual confidence in taking care of their health. However, only race/ethnicity and insurance showed positive associations with screening adherence across all three guidelines. NHB women and women with insurance coverage were consistently found to have positive associations with adherence to screening regardless of the guideline being applied, whereas other factors were found to be associated with screening adherence only when a certain guideline was applied. For example, an individual's education level was only found to be associated with adherence to mammogram screening when the USPSTF guideline was applied (**Table 6**). However, individuals' confidence in their health was not associated with the adherence to mammogram screening when using the USPSTF guideline. In addition, marital status was not associated when ACR guideline was applied, and education level was not associated when ACS guideline was applied (**Table 6**).

DISCUSSION

Breast cancer screening plays an important role in early cancer diagnosis and treatment (26). In our study, the overall mammographic screening adherence was less than 80% regardless of which screening guideline was used, indicating potential improvement needed on breast cancer screening compliance. Our study also found higher mammographic screening adherence when the USPSTF guideline was applied to the study participants. Additionally, when we analyzed the association of screening adherence with women of different races/ethnicities, NHB women had a relatively higher adherence to the ACR guideline with comparison to Hispanic/Latino or NHW women indicating the existence of racial/ethnic disparities in breast cancer screening. Furthermore, NHB

Table 4. Adherent to mammographic screening when different screening guidelines were applied

Screening adherence	USPSTF	ACR	ACS
	N, wt%	N, wt%	N, wt%
Females recommended for breast cancer screening	1,114, ---	1,751, ---	1,600, ---
Adherent mammographic screening	891, 77.37%	1,047, 57.71%	1,150, 68.41%
Not adherent mammographic screening	223, 22.63%	704, 42.29%	450, 31.59%

NOTE: Statistically significant differences occurred in terms of adherence to mammogram screening when three different guidelines were compared with the Rao-Scott Chi-square test ($p < 0.001$ in USPSTF versus ACR, USPSTF versus ACS, and ACR versus ACS comparisons).

Table 5. Adherence to mammographic screening when different screening guidelines were applied

	NHW		NHB		Hispanic/Latino		Others	
	N	wt%	N	wt%	N	wt%	N	wt%
USPSTF (p = 0.2877)								
Adherent	500	74.80	146	81.41	114	83.18	131	82.11
Not adherent	136	25.20	26	18.59	25	16.82	36	17.89
ACR (p = 0.0268)								
Adherent	580	57.36	173	67.64	129	44.16	165	60.03
Not adherent	387	42.64	84	32.36	112	55.84	121	39.97
ACS (p = 0.3428)								
Adherent	641	67.69	180	73.32	138	60.61	191	71.93
Not adherent	256	32.31	54	26.68	62	39.39	78	28.07

NOTE: Statistically significant racial/ethnic differences were found with the ACR guideline (Rao Scott Chi square test to compare four group differences, p = 0.0268), while no significant racial/ethnic differences were found with other guidelines such as USPSTF or ACS (p > 0.05). NHB individuals had a higher mammogram screening adherence rate in comparison to Hispanic/Latino individuals (p < 0.01) and NHW individuals (p = 0.05) when ACR guideline was applied.

Table 6. Factors associated with adherence mammogram screening under different breast cancer screening guidelines

	USPSTF			ACR			ACS		
	AOR	95% CI	p	AOR	95% CI	p	AOR	95% CI	p
Patient demographics/SDoH									
Age									
40–44-year-old				Ref					
45–49-year-old				1.28	(0.58, 2.83)	0.531	Ref		
50–54-year-old	Ref			1.59	(0.72, 3.48)	0.243	1.21	(0.55, 2.65)	0.626
55–74-year-old	1.22	(0.51, 2.89)	0.653	1.37	(0.64, 2.91)	0.411	2.45	(1.38 ,4.35)	0.003
75 years +				0.62	(0.29,1.34)	0.222	0.82	(0.36, 1.83)	0.617
Race and ethnicity									
Non-Hispanic White	Ref			Ref			Ref		
Non-Hispanic Black	2.79	(1.08, 7.17)	0.034	2.74	(1.67, 4.52)	<0.001	3.24	(1.79, 5.83)	<0.001
Hispanic/Latino	3.62	(0.85,15.43)	0.081	0.86	(0.50, 1.48)	0.577	1.10	(0.56, 2.14)	0.784
Others	1.75	(0.34, 9.17)	0.497	1.01	(0.48, 2.15)	0.978	1.21	(0.4, 3.45)	0.712
Education level									
High school or below	Ref			Ref			Ref		
Some college	0.83	(0.34, 2.00)	0.673	1.13	(0.68, 1.87)	0.632	1.16	(0.64, 2.13)	0.615
College or above	3.05	(1.16, 8.03)	0.025	1.19	(0.68, 2.09)	0.529	1.68	(0.93, 3.02)	0.083
Marital Status									
Single	Ref			Ref			Ref		
Married	1.42	(0.53, 3.82)	0.480	1.61	(0.85, 3.06)	0.143	2.45	(1.33, 4.53)	0.005
Others	1.40	(0.48, 4.02)	0.528	1.13	(0.58, 2.21)	0.712	1.84	(0.96, 3.52)	0.065
Patient health information/conditions									
Insurance coverage									
No	Ref			Ref			Ref		
Yes	6.18	(1.76, 21.64)	0.005	3.49	(1.41, 8.62)	0.008	5.28	(1.67, 16.71)	0.006
Having regular HCP									
No	Ref			Ref			Ref		
Yes	1.70	(0.74, 3.89)	0.206	1.68	(1.03, 2.74)	0.036	1.80	(0.94, 3.46)	0.076
Confidence of health									
No/A little confident	Ref			Ref			Ref		
Somewhat confident	1.31	(0.21, 8.01)	0.769	1.81	(0.77, 4.25)	0.172	2.04	(0.58, 7.21)	0.263
Very/completely confident	2.02	(0.30,13.58)	0.463	2.90	(1.23, 6.83)	0.016	2.86	(0.81,10.08)	0.101

NOTE: Multivariate logistic regression was used to determine the associations between 15 independent factors and adherence mammogram screening. Women aged 50-54 were used as the reference group since no women aged 40–49 were included in the USPSTF guideline. Women aged 45-49 were used as the reference group since no women aged 40–44 were included in the ACS guideline. Reference (ref) indicates control group used in each categorical variable in multivariate logistic regression analysis. Eight variables that did not show statistically significant differences were not reported here.

women and women with insurance coverage showed positive associations with adherence to mammographic screening regardless of the guidelines applied. Our findings validated other studies' reports and can serve as a foundation for further implementation of suitable interventions to improve breast cancer screening (27, 28). In terms of different screening guidelines, previous studies mainly focused on benefit and harms comparisons between the different sets of guidelines (29). Whereas few studies have performed analyses on the comparison of different adherence rates when different guidelines were applied. One study used 2014 survey data to compare adherence using USPSTF, ACS, ACR, and ACOG guidelines and found that the adherence rate ranged from 76–81% with USPSTF, 55–81% with ACS, and 45–64% with ACR/ACOG guidelines (10). The adherence rates from this study seems to be a slightly higher when compared to our study findings and the ranged percentages came from the adherence rates of different age groups. However, our study paid more attention on investigating the adherence rates of different races/ethnicities. Apart from this, guidelines are periodically updated, and sometimes minor changes occur. For example, ACS guideline 2015 version was used in our study, whereas ACS guideline 2003 version was used in the previous study with the change of female aged 40 or older requiring annual mammogram to female 55 or older requiring mammogram biennially (30). Therefore, it is necessary to perform another comparison study applying the updated guidelines.

Our overall screening adherence rates were below 80%, which is lower than the rate reported from other studies (9, 10). This may reflect a relatively high NHW population included in data from the national survey that was utilized because NHW women have been reported to have a lower mammographic screening rate than NHB women, but the mechanisms of such findings are still unclear. Another study attempted to explain the breast cancer screening cultural change among NHBs (i.e., NHB individuals were more willing to perform breast cancer screening), but it did not provide strong evidence (27, 31). Higher breast cancer screening rate among NHB women in comparison to NHW women may be explained due to the higher mortality rates from breast cancer among NHB women compared to those of NHW women, especially among NHB women younger than 50 (32). Less optimal outcomes among NHB women might cause higher rates of breast cancer screenings. It is also possible that providers encourage more frequent breast cancer screening among NHB women (33). In addition to the NHB population, our study also found insurance coverage acted as another independent factor promoting the breast cancer screening. Insurance and access to healthcare providers are essential for breast cancer screening adherence (28, 34, 35). Previous studies found that people lacking insurance coverage tended to have less primary care clinic visits, perform fewer regular checkups, with lower rates of cancer screenings when compared with their counterparts (36, 37). Cancer screening shows great benefit when performed appropriately and increasing adherence for cancer screening may improve early cancer detection, survival, and health. Therefore, we suggest that healthcare providers, especially primary care physicians, recommend patients to perform breast cancer screening. In addition, due to relatively lower adherence rates among NHW/Hispanic/Latino women and women lacking insurance coverages, interventions may need to be implemented focusing on such risks. For example, increasing primary care physician assignment and routine clinic visits among NHW/Hispanic women, enhancing community breast cancer screening awareness program, and providing social-financial support for women lack insurance coverage may all be beneficial to raising the adherence rates.

This study has several strengths. First, our study used a nationally representative survey with a large sample size across the nation, which can increase the population diversity and further increase the generalizability of the study findings. Secondly, we compared the current most common breast cancer screening guidelines in our comprehensive analyses. Our findings provided insights into differences in adherence rates to the different guidelines. Lastly, we used a multivariate logistic regression to determine multiple factors associated with the mammographic screening adherence. Using this statistical method, we could not only identify independent factors related to breast cancer screening, but also avoid confounding factors (factors that seem to be associated with appropriate screening in a simple two-group comparison but were found to have no association by using multivariate logistic regression analysis).

Nevertheless, this study has some limitations. First, since this is a survey study with retrospective analysis, incorrect variables and incomplete or missing information cannot be avoided, which can lead to the deviation of the study findings. Secondly, when different breast cancer screening criteria were used, especially ones that prefer mammographic screening once every two years, we considered women whose most recent mammogram performed within two years as "adherent" to guideline. The HINTS survey only asked for when the most recent mammographic screening was. Participants who checked "1–2 years ago" for their most recent screening were categorized as adherent to the guidelines that recommended mammographic screening once every two years. However, since we only know that those participants had a recent mammogram 1–2 years ago, there might be participants who had multiple mammograms within the 1–2 year period and thus qualify for "once every year." Unfortunately, we are not able to differentiate these two scenarios which could lead to the overestimation of guideline adherence rates. Some guidelines (e.g., ACR and ACS) also recommend stopping screening for individuals whose life expectancy is less than 10 years. It is challenging to predict an individual's life expectancy; therefore, we assumed all participants in this study had life expectancy of more than 10 years which could lead to the underestimation of guideline

adherence rates. Thirdly, we only used multivariate logistic regression to determine the association between independent factors and mammographic screening adherence. There are other approaches, such as using artificial intelligence and machine learning (AI/ML) algorithms to determine important features associated with mammographic screening adherence. Using AI/ML algorithms, such as random forest, could more accurately identify important factors contributing to the screening adherence rather than using multivariate logistic regression analysis because using AI/ML can determine which risk factor contributes more in related to the higher guideline adherence, whereas multivariable logistic regression is only able to determine their positive or negative associations. Finally, since the survey did not include screening results, we are unable to link screening patterns to clinical outcomes such as prevalence of breast cancer or mortality. Therefore, a large-scale prospective observational study with follow up among participants is warranted.

In summary, our study shows that using the USPSTF guideline resulted in a relatively higher adherence rate for breast cancer mammographic screening among U.S. women at average-risk of breast cancer. When analyzed with women of different races/ethnicities, NHB women had a relatively higher adherence to ACR guidelines in comparison to Hispanic/Latino or NHW women. In addition, having insurance coverage seemed to be associated with better mammographic screening adherence. A mammographic screening may lead to the early detection and treatment of breast cancer, thus resulting in a better clinical outcome.

MATERIALS AND METHODS

Study design and data source

This is a cross-sectional observational study. We analyzed the data from the 2020 Health Information National Trends Survey (HINTS 5 cycle 4) that was updated and released in May 2022. HINTS is a nationally representative survey of non-institutionalized civilian households administered by the National Cancer Institute (38). The survey collects information on breast cancer screening, individual demographic characteristics, and social determinants of health like education, insurance coverage, and income of households. The HINTS study is issued once every few years and each cycle in HINTS 5 is administered over the course of four years. HINTS 5 Cycle 4 was conducted from February 24 – June 15, 2020. HINTS is a publicly available de-identified dataset, and it was approved by the regional institution review board and determined as a non-human research project.

Participants

The study participants were limited to individual females aged 40 and above in the U.S. We excluded 1) males or individuals with unknown gender and 2) individuals with age less than 40 or missing data for age.

Breast cancer mammographic screening

The National Cancer Institute uses the following question in the HINTS to determine whether breast cancer screening has been performed among U.S. women: “When did you have your most recent mammogram to check for breast cancer, if ever?” The answers were listed as 1) one year ago or less; 2) more than one, up to two years ago; 3) more than two, up to three years ago; 4) more than three, up to five years ago; 5) more than five years ago, and 6) I have never had a mammogram. At present, mammogram screening criteria are published by different societies/organizations but are not consistent on the initial screening age (i.e., 40- vs 45- vs 50-year-old) and frequency of screening (i.e., once a year versus once every 2 years). We reviewed seven guidelines used frequently by healthcare providers. USPSTF, ACP, AAFP, and ACOG recommend the same screening guideline (hereafter referred to as USPSTF guideline), ACR and NCCN recommend the same guideline (hereafter referred to as ACR guideline), and ACS uses another guideline (hereafter referred to as ACS guideline, see detail in **Table 1**). Using this method, we classified these seven guidelines into three groups, Group 1: USPSTF guideline, Group 2: ACR guideline, and Group 3: ACS guideline. Each guideline provides their inclusion criteria for mammogram screening. Individuals who met the inclusion criteria were included. Among these included women, ones who performed the mammogram and satisfied a given group guideline were considered as adherent to mammographic screening for that group, whereas individuals who did not satisfy such a given group guideline were considered as not adherent. We calculated the percentages of adherent and non-adherent women within the given group (i.e., percentages of the guideline adherent rate equal the number of women whose mammograms performed in compliance with the guideline divided by the number of women recommended by guideline for mammogram screening, and the addition of adherent and non-adherent percentages equal to 100%).

Key explanatory variables

Based on the data from previous studies, we included in our analyses several factors previously shown to be associated with mammographic screening adherence (39, 40). We divided these factors into three main categories: 1) individual demographics/social determinants of health (SDoH); 2) individual health information/conditions; and 3) patient-provider rapport/communication. These three categories were the most tested factors in other studies and the focus of our study. All three categories were distinctive characteristics and parts of the individual participant’s data (39, 40). Individual demographics/SDoH included age, race/ethnicity, education levels, marital status, household income levels, and location. Individual health information/conditions included whether the person had insurance coverage, had a regular healthcare provider, had a history of depression or anxiety, was a smoker, had a family history of cancer, and had confidence taking care of their own health. Patient-provider

rapport included whether the provider involved individuals in decisions about their health condition and whether the provider made sure the individual understood the things they needed to do to take care of their health. Multivariate logistic regression was used to determine the associations between these factors and mammographic screening adherence by three guidelines.

Statistical analysis

Since HINTS is a survey with replicate weights (each individual surveyor stands for multiple people), weighted percentages were recorded amongst each category (wt%). Breast cancer screening rates were calculated for different age groups (i.e., 40–44, 45–49, 50–54, 55–74, and 75+), and different races/ethnicities (i.e., non-Hispanic white, non-Hispanic black, Hispanic/Latino, and others). Significant differences between groups were tested with Rao-Scott Chi-square tests. A multivariate logistic regression analysis was conducted to determine the association between mammogram screening adherence and multiple different independent factors. As previously described above, the binary dependent variable was mammography screening (i.e., adherent vs. not adherent). Adjusted odds ratios (AOR) with 95% confidence intervals (CI) were calculated for each independent variable tested in the multivariate logistic regression analysis. All statistical analyses were conducted using STATA 14.2 (College Station, TX, USA). We followed the HINTS guidelines for analysis and used survey procedures with replicate weights for all analyses.

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REFERENCES

1. Fitzmaurice, Christina, *et al*. "Global, Regional, and National Cancer Incidence, Mortality, Years of Life Lost, Years Lived with Disability, and Disability-Adjusted Life-years for 32 Cancer Groups, 1990 to 2015: A Systematic Analysis for the Global Burden of Disease Study." *JAMA Oncology*. vol. 3, no. 4, 2017, pp. 524-48. https://doi.org/10.1001/jamaoncol.2016.5688.
2. "About Breast Cancer" by American Cancer Society. www.cancer.org/cancer/types/breast-cancer/about.html. Accessed 8-1-2023
3. Lauby-Secretan, Béatrice *et al*. "Breast-cancer screening--viewpoint of the IARC Working Group." *The New England journal of medicine*. 372,24 (2015): 2353-8. https://doi.org/10.1056/NEJMsr1504363.
4. Berry, Donald A *et al*. "Effect of screening and adjuvant therapy on mortality from breast cancer." *The New England journal of medicine*. 353,17 (2005): 1784-92. https://doi.org/10.1056/NEJMoa050518.
5. Qaseem, Amir *et al*. "Screening for Breast Cancer in Average-Risk Women: A Guidance Statement from the American College of Physicians." *Annals of internal medicine* vol. 170,8 (2019): 547-560. https://doi.org/10.7326/M18-2147.
6. Oeffinger, Kevin C *et al*. "Breast Cancer Screening for Women at Average Risk: 2015 Guideline Update from the American Cancer Society." *JAMA* vol. 314,15 (2015): 1599-614. https://doi.org/10.1001/jama.2015.12783.
7. "What Is a Mammogram?" *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, www.cdc.gov/cancer/breast/basic_info/mammograms.htm. Accessed 9-26-2022.
8. Nelson, Heidi D *et al*. "Effectiveness of Breast Cancer Screening: Systematic Review and Meta-analysis to Update the 2009 U.S. Preventive Services Task Force Recommendation." *Annals of internal medicine* vol. 164,4 (2016): 244-55. https://doi.org/10.7326/M15-0969.
9. "Mammography Screening and Related Breast Care Still Rebounding from Covid-19 Pandemic." *American College of Radiology*, www.acr.org/Media-Center/ACR-News-Releases/2022/Mammography-screening-and-related-breast-care-still-rebounding-from-COVID-19-pandemic. Accessed 12-2-2022.
10. Narayan, Anand *et al*. "Nationwide cross-sectional adherence to mammography screening guidelines: national behavioral risk factor surveillance system survey results." *Breast cancer research and treatment* vol. 164,3 (2017): 719-725. https://doi.org/10.1007/s10549-017-4286-5.
11. Ren, Wenhui *et al*. "Global guidelines for breast cancer screening: A systematic review." *Breast (Edinburgh, Scotland)* vol. 64 (2022): 85-99. https://doi.org/10.1016/j.breast.2022.04.003.
12. "Breast Cancer: Screening." *Recommendation: Breast Cancer: Screening | United States Preventive Services Taskforce*, US Preventive Services Taskforce, 11 Jan. 2016, www.uspreventiveservicestaskforce.org/uspstf/recommendation/breast-cancer-screening. Accessed 9-26-2022.
13. "*ACS Breast Cancer Screening Guidelines"* www.cancer.org/cancer/breast-cancer/screening-tests-and-early-detection/american-cancer-society-recommendations-for-the-early-detection-of-breast-cancer.html. Accessed 9-26-2022.
14. "Practice Bulletin Number 179: Breast Cancer Risk Assessment and Screening in Average-Risk Women." *Obstetrics and gynecology* vol. 130,1 (2017): e1-e16. https://doi.org/10.1097/AOG.0000000000002158.
15. Mango, Victoria *et al*. "Commentary ACOG Practice Bulletin July 2017: Breast Cancer Risk Assessment and Screening in Average-Risk Women." *The British journal of radiology* vol. 91,1090 (2018): 20170907. https://doi.org/10.1259/bjr.20170907.
16. Monticciolo, Debra L *et al*. "Breast Cancer Screening Recommendations Inclusive of All Women at Average Risk: Update from the ACR and Society of Breast Imaging." *Journal of the American College of Radiology : JACR*

vol. 18,9 (2021): 1280-1288. https://doi.org/10.1016/j.jacr.2021.04.021.
17. Khan, Muneeza, and Anna Chollet. "Breast Cancer Screening: Common Questions and Answers." *American family physician* vol. 103,1 (2021): 33-41.
18. Bevers, Therese B *et al*. "Breast Cancer Screening and Diagnosis, Version 3.2018, NCCN Clinical Practice Guidelines in Oncology." *Journal of the National Comprehensive Cancer Network: JNCCN* vol. 16,11 (2018): 1362-1389. https://doi.org/10.6004/jnccn.2018.0083.
19. Khaliq, Waseem *et al*. "Predictors of Non-Adherence to Breast Cancer Screening among Hospitalized Women." *PloS one* vol. 10,12 e0145492. 28 Dec. 2015, https://doi.org/10.1371/journal.pone.0145492.
20. Vyas A, Madhavan S, Kelly K, Metzger A, Schreiman J, Remick S. "Predictors of self-reported adherence to mammography screening guidelines in West Virginia women visiting a stationary facility." W V Med J. 2014 Mar-Apr;110(2):20-6. PMID: 24902464; PMCID: PMC4896067.
21. Hirth, Jacqueline M *et al*. "Racial/Ethnic Differences Affecting Adherence to Cancer Screening Guidelines Among Women." *Journal of women's health (2002)* vol. 25,4 (2016): 371-80. https://doi.org/10.1089/jwh.2015.5270.
22. Rosenberg, Lynn *et al*. "A multilevel study of socioeconomic predictors of regular mammography use among African American women." *Cancer epidemiology, biomarkers & prevention: a publication of the American Association for Cancer Research, cosponsored by the American Society of Preventive Oncology* vol. 14,11 Pt 1 (2005): 2628-33. https://doi.org/10.1158/1055-9965.EPI-05-0441.
23. Selvin, Elizabeth, and Kate M Brett. "Breast and cervical cancer screening: sociodemographic predictors among White, Black, and Hispanic women." *American journal of public health* vol. 93,4 (2003): 618-23. https://doi.org/10.2105/ajph.93.4.618.
24. Yazgan, Idil, and Anees Chagpar. "The effect of emotional disorders on adherence to mammography screening guidelines." *Breast cancer research and treatment* vol. 192,3 (2022): 623-627. https://doi.org/10.1007/s10549-022-06538-y.
25. Spring, Laura M *et al*. "Mammography decision making: Trends and predictors of provider communication in the Health Information National Trends Survey, 2011 to 2014." *Cancer* vol. 123,3 (2017): 401-409. https://doi.org/10.1002/cncr.30378.
26. Duffy, Stephen W *et al*. "Beneficial Effect of Consecutive Screening Mammography Examinations on Mortality from Breast Cancer: A Prospective Study." *Radiology* vol. 299,3 (2021): 541-547. https://doi.org/10.1148/radiol.2021203935.
27. Razavi, Marianne *et al*. "Association of time intervals in cancer screenings and older participants' characteristics, in a nationally representative sample." *Journal of geriatric oncology*, S1879-4068(22)00241-7. 4 Nov. 2022, https://doi.org/10.1016/j.jgo.2022.10.007
28. Chamot, Eric *et al*. "Women's preferences for doctor's involvement in decisions about mammography screening." *Medical decision making: an international journal of the Society for Medical Decision-Making* vol. 24,4 (2004): 379-85. https://doi.org/10.1177/0272989X04267011.
29. Mandelblatt, Jeanne S *et al*. "Collaborative Modeling of the Benefits and Harms Associated With Different U.S. Breast Cancer Screening Strategies." *Annals of internal medicine* vol. 164,4 (2016): 215-25. https://doi.org/10.7326/M15-1536.
30. Smith, Robert A *et al*. "American cancer society guideline for breast cancer screening: update 2003." *CA Cancer J Clin*, vol. 53, 3 (2003): 141-169. https://doi.org/10.3322/canjclin.53.3.141.
31. Virk-Baker, Mandeep K *et al*. "Mammography utilization among Black and White Medicare beneficiaries in high breast cancer mortality US counties." *Cancer causes & control : CCC* vol. 24,12 (2013): 2187-96. https://doi.org/10.1007/s10552-013-0295-9.
32. Hunt, Bijou R, and Marc S Hurlbert. "Black:white disparities in breast cancer mortality in the 50 largest cities in the United States, 2005-2014." *Cancer epidemiology* vol. 45 (2016): 169-173. https://doi.org/10.1016/j.canep.2016.07.018.
33. Radhakrishnan, Archana *et al*. "Linking physician attitudes to their breast cancer screening practices: A survey of US primary care providers and gynecologists." *Preventive medicine* vol. 107 (2018): 90-102. https://doi.org/10.1016/j.ypmed.2017.11.010.
34. Peek, Monica E, and Jini H Han. "Disparities in screening mammography. Current status, interventions, and implications." *Journal of general internal medicine* vol. 19,2 (2004): 184-94. https://doi.org/10.1111/j.1525-1497.2004.30254.x.
35. Schueler, Kristin M *et al*. "Factors associated with mammography utilization: a systematic quantitative review of the literature." *Journal of women's health (2002)* vol. 17,9 (2008): 1477-98. https://doi.org/10.1089/jwh.2007.0603.
36. Pronce-Chazarri L, *et al*. "Barriers to breast cancer-screening adherence in vulnerable populations." *Cancer (Basel)* vol. 15, 3 (2023): 604. https://doi.org/10.3390/cancers15030604.
37. McWilliams, Michael J. "Health consequences of uninsurance among adults in the United States: recent evidence and implications." Milbank Q vol. 87, 2 (2009): 443-94. https://doi.org/ 10. 1111/j.1468-0009.2009.00564.x.
38. Finney Rutten, Lila J *et al*. "Data Resource Profile: The National Cancer Institute's Health Information National Trends Survey (HINTS)." *International journal of epidemiology* vol. 49,1 (2020): 17-17j. https://doi.org/10.1093/ije/dyz083.
39. Ezema Rita N, *et al*. "association of sociodemographic factors, breast cancer fear, and perceived self-efficacy with breast cancer screening among middle-aged Nigerian women." *Breast Cancer (Auckl)* vol 15 (2021):11782234211043651. https://doi.org/10.1177/11782234211043651.

40. Henderson Louise M, *et al*. "The role of social determinants of health in self-reported access to health care among women undergoing screening mammography." *J Womens Health (Larchmt)* vol 29, 11 (2020): 1437-1446. https://doi.org/ 10.1089/jwh.2019.8267.