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Multilevel Small Area Estimation for County-Level Prevalence of Mammography Use in the United States Using 2018 Data

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Abstract

Background: The U.S. Preventive Services Task Force recommends biennial screening mammography for average-risk women aged 50–74 years. We aim to generate county-level prevalence estimates for mammography use to examine disparities among counties.

Materials and Methods: We used data from the 2018 Behavioral Risk Factor Surveillance System (BRFSS) (n = 111,902 women) and linked them to county-level data from the American Community Survey. We defined two outcomes: mammography within the past 2 years (current); and mammography 5 or more years ago or never (rarely or never). We poststratified the data with U.S. Census estimated county population counts, ran Monte Carlo simulations, and generated county-level estimates. We aggregated estimates to state and national levels. We validated internal consistency between our model-based and BRFSS state estimates using Spearman and Pearson correlation coefficients.

Results: Nationally, more than three in four women [78.7% (95% confidence interval {CI}: 78.2%–79.2%)] were current with mammography, although with large variations among counties. Also, nationally, about one in nine women [11% (95% CI: 10.8%–11.3%)] rarely or never had a mammogram. County estimates for being current ranged from 60.4% in New Mexico to 86.9% in Hawaii. Rarely or never having a mammogram ranged from 6% in Connecticut to 23.0% in Alaska, and on average, almost one in eight women in all the counties. Internal consistency correlation coefficient tests were ≥0.94.

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Disclaimer
The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the CDC or of the U.S. Bureau of Labor Statistics.

Ethics Statement
The study was exempted from Institutional Review Board's approval because it was based on secondary data without respondents' private information.

Author Disclosure Statement
The authors declare no potential conflicts of interest.

Conclusions: Our analyses identified marked county variations in mammography use across the country among women aged 50–74 years. We generated estimates for all counties, which may be helpful for targeted outreach to increase mammography uptake.

Keywords

multilevel small area estimation; county-level estimates; breast cancer screening; mammography

Introduction

THE U.S. PREVENTIVE SERVICES TASK FORCE (USPSTF) recommends biennial mammography screening for most women aged 50–74 years, concluding that mammography reduces breast cancer mortality rate in this age group and that biennial screening provides the best overall balance of benefit and harm for these women.[1] In the United States, female breast cancer is the most common type of cancer overall after skin cancer, and it is the second leading cause of cancer death among women.[2] Each year, well over a quarter million women are diagnosed with breast cancer, and more than 42,000 women die from this disease; these numbers continue to increase each year.[3]

A 2018 National Health Interview Survey (NHIS) analysis of breast cancer screening found that 72.4% (age-standardized 72.3%) of women aged 50–74 years had received screening in the past 2 years, just under nine percentage points lower than the Healthy People 2020 (HP2020) target of 81.1%.[4] Based on the NHIS data, the HP2030 target was reset at 77.1%.[5] A 2018 study comparing estimated mammography use between the Behavioral Risk Factors Surveillance System (BRFSS) from 2012 to 2014 and NHIS from 2010 to 2013 found the prevalence of being current (<2 years) with screening to be 78.4% using BRFSS data and 72.5% using NHIS data,[6] a difference that may be due to different methods.

The 2018 NHIS analysis[4] found that on a national level, the percentage federal poverty threshold, education, and usual source of care, among other demographic characteristics, might have contributed to large disparities in mammography uptake according to USPSTF recommendations. These findings warrant further investigation of the barriers to improving mammography use.

Underlying national estimates of screening test use is considerable variability in screening prevalence by location across and within states.[7,8] The goal of our study is to examine county-level geographic variations in mammography use and identify counties with low mammography use where women may benefit from interventions to increase breast cancer screening. Our analysis includes two groups of women representing two screening outcomes: (1) women who had a mammogram within 2 years (defined as current) according to the USPSTF recommendations; and (2) women who had their most recent mammogram 5 or more years before the survey interview or never had one (defined as rarely or never screened).

Examining geographic differences in mammography use among women who rarely or never had a mammogram is of utmost importance because women with breast cancer who never had a mammogram or those who seldom screen are more likely to be diagnosed with advanced disease. Moreover, women who live in underserved areas might benefit from services or interventions to increase their access to and utilization of screening mammography.[9]

Materials and Methods

We used the 2018 BRFSS restricted data, including state and county information, and combined them with demographic and mammography use data for each woman respondent aged 50–74 years. The BRFSS is administered by the Centers for Disease Control and Prevention (CDC) in collaboration with 50 state health departments, the District of Columbia, and two U.S. territories.[10] The survey is state-based and uses random-digit dialing to collect health-related information from noninstitutionalized adults aged 18 years or older.[10] The weighted median response rate in 2018 for combined landline and cell phone samples was 49.9% and ranged from 38.8% in California to 67.2% in South Dakota. Women aged 40 years and older were asked ‘‘Have you ever had a mammogram?’’ Those who answered ‘‘No’’ were assigned as never having had a mammogram. Women who answered ‘‘Yes’’ were further asked ‘‘How long it has been since you had your last mammogram?’’

We examined two outcomes: being current with mammography (<2 years ago); and rarely or never having had a mammogram (5 or more years ago, or never). We included only women aged 50–74 years, consistent with the current USPSTF recommendation for breast cancer screening.[1] We excluded women who did not know or refused to answer about their mammography history (1.1%). We also excluded women associated with the race and ethnicity group ‘‘other’’ in BRFSS to allow for matching our categories to the U.S. Census categories.

Because BRFSS did not distinguish whether the mammogram was for screening or diagnostic purposes, we consider our analysis as a general measure of mammography use as have other researchers using mammography data.[4]

Statistical analysis

Our BRFSS analysis included data from a sample of 111,902 women who answered questions about their mammography history. We linked the data with the American Community Survey county-level poverty rate estimates (2014–2018) (<150% of the federal poverty rate),[11] which we received from the U.S. Census. We then fitted separate multilevel logistic regression mixed models for being current with mammography, or rarely or never having had a mammogram. Our models had fixed and random effects.[7] Fixed effects included five age groups (50–54, 55–59, 60–64, 65–69, 70–74 years), seven racial and ethnic groups [non-Hispanic (NH) white, NH black, NH American Indian/Alaska Native, NH Asian, NH Pacific Islander, NH two or more races, and Hispanic], and county-level poverty. Random effects included the variables state and county.

We excluded the category ‘‘NH other race’’ to match the variable race and ethnicity to the U.S. Census respective data variable, which has seven race and ethnicity categories and was later used in our simulations. The category ‘‘NH other race’’ comprised a very small percentage (0.45% weighted and <0.6% unweighted) of the BRFSS race and ethnicity variable. Therefore, the removal of that category had no substantial effect on the two mammography outcomes. We fitted the multilevel logistic regression models with the GLIMMIX procedure, SAS version 9.4 (SAS Institute, Inc.). The GLIMMIX results had missing random effects for counties missing BRFSS data for analysis. These counties are often located in rural areas. To make a prediction for the population within these counties while incorporating the county-level contextual effects on mammography outcomes, we used an intuitive spatial smoothing method[12,13] to generate the county random effects.

The random effect of a county without a sample is generated by the average of its neighboring counties with BRFSS samples by borrowing contextual information from the surrounding counties. This spatial smoothing approach works well because BRFSS has sampled more than 95% of U.S. counties.

After populating all the counties with random effects data, we aligned the BRFSS county data more closely with the U.S. Census data. We poststratified the BRFSS data (5 age groups × 7 race and ethnicity groups × 3,142 counties) with U.S. Census County population counts[14] and used them with the updated random effects list to estimate parameters in each model in newly developed Monte Carlo simulation programs. Each simulation consisted of 1,000 randomly drawn samples for each of the parameters and their standard errors to predict the individual-level expected probability of being current with mammography screening or rarely or never having been screened. The random effects reflect the county contextual effect on the outcome.

We ran our multilevel logistic regression models using the generalized linear mixed models' general formula, a method similar to the one used in previous publications[7,8]:

$$P_{ijcs}(y_{ijcs} = 1) = \text{logit}^{-1}(\alpha_i + \gamma_j + x_c'\eta + \mu_c + \nu_s)$$

For example, for the first outcome, y_{ijcs} is the self-reported screening status (1 = current, 0 = not current or never been screened) for an individual in age group i, $i = 1$ to 5, and race and ethnicity group j, $j = 1$ to 7, from county c in state s, and their respective regression coefficients. x_c is a vector of county-level covariates, and η is a vector of their respective regression coefficients. The prediction model included a product of the county-level poverty status x_c' and its respective regression coefficient η. μ_c and ν_s are the county- and state-level random effects, which were assumed to be independent and normally distributed.[7] y_{ijcs} for the second group includes the two independent groups: 1 = rarely or never been screened, 0 = screened within 5 years.

Our simulation models generated estimates for the expected probability of an individual in each of the geodemographic groups being current with breast cancer screening or rarely or never having been screened in each of the 3,142 U.S. counties. Using the population available for each geodemographic group, we aggregated the specific geodemographic group prevalence estimates for each outcome to generate predicted mean values, their standard errors, and 95% confidence intervals (CI) by county, by state, and for the entire United States. Further information and formulae for this process have been previously described.[7,8]

We calculated summary statistics for the model-based county distributions with the univariate procedure. Summary statistics for state estimates for the 2018 BRFSS direct estimates were calculated with the MEANS and univariate procedures.

Because the BRFSS is a state-based surveillance system, we validated the internal consistency between the BRFSS and the model-based state estimates with Spearman and Pearson correlation coefficients. We were not able to validate the internal consistency of all counties because BRFSS had missing sample information in some counties. We used ESRI ArcGIS 10.8.1 (Esri, Redlands, CA) to separately map the model-based county estimates for each of the two outcomes. The multilevel simulation models were fitted with SAS 9.4 (SAS Institute, Inc.). BRFSS states' summary estimate calculations for internal consistency were performed with SAS-callable SUDAAN (Research Triangle Institute, Research Triangle Park, NC).

Results

After poststratification, national model-based estimates for being current with mammography (78.7%) and rarely or never having had a mammogram (11.0%) were almost the same as the 2018 direct BRFSS national prevalence estimates (78.7% and 10.9% respectively), each with 95% CIs overlapping (Table 1). Overall, the model-based mean state prevalence of being current with mammography (78.0%) and rarely or never having been screened (11.3%) were very similar to those of BRFSS (77.8% and 11.7%, respectively). The overall ranges of BRFSS state estimates were larger than those of the model-based estimates. These differences might be due to the simulation process, which often results in tighter estimates at the extremes. However, the Spearman and Pearson correlation coefficients between survey and model-based state prevalence estimates ranged from 0.94 and 0.96, and their means and medians were very similar.

Model-based state prevalence varied from 69.4 percentage points in Idaho to more than 84.0 percentage points in Massachusetts and Hawaii (Tables 1 and 2). Thirty-two states had state prevalence of current mammography higher than 77.1%, the national 2030 HP target. Alaska, Idaho, New Mexico, Nevada, and Wyoming, on the contrary, had the lowest state prevalence at <72%. State prevalence estimates of having a mammogram rarely or never varied from less than 8.0 percentage points in the District of Columbia, Connecticut, Massachusetts, and Rhode Island to 16.4% in Idaho (Tables 1 and 2). Alaska, Wyoming, Montana, Nevada, and Mississippi had a state prevalence at ≥14%.

The overall mean county estimate for being current with mammography was 76.7%, and county-level prevalence varied from a minimum of 60.4 percentage points in New Mexico to a maximum of 86.9 percentage points in Hawaii, with Massachusetts and Connecticut slightly behind (Table 2; Fig. 1A).

Figure 1A also suggests that metropolitan areas have the highest prevalence of being up-to-date with screening.

Differences in prevalence estimates of current mammography use within states, shown by overall ranges, varied from 2.4% in Delaware and less than 6.0% in North Carolina, Maine, Rhode Island, and Massachusetts to more than 14.0% in Alaska and New Mexico and 19.0% in South Dakota. Thirty states had an overall range of less than 10.0%, indicating a more even distribution of screening across counties. The overall mean county estimate of rarely or never having had a mammogram was 12.3%, and county-level prevalence estimates varied from ~6.0% in Connecticut and 6.1% in Maryland to 23.0% in Alaska (Table 2). Overall mean and median county estimates were similar at about 12.0% each (Tables 1 and 2; Fig. 1A). Figure 1B also suggests that rural areas have the highest prevalence of women who are rarely or never screened.

Discussion

Our findings show that, nationally, among women aged 50–74 years, more than three in four were current with mammography, and one in nine, translating to more than 5 million women in the population, rarely or never had a mammogram. These proportions are almost the same as the 2014 national mammography prevalence estimates of 78.4% and 11.2%, respectively,[7] consistent with evidence that the proportion of women in this age range who received mammography within 2 years did not change substantially from 2005 to 2018.[4] Nevertheless, the absolute number of women current with mammography in 2018 did increase from 2005, reflecting population growth among women age-eligible for testing.[4] More than 30% of states had an estimated mean percentage of women who were current with mammography below the new national HP2030 target of 77.1%,[5] however, there was considerable variation across states and counties.

Multiple states had counties with relatively high percentages of women who rarely or never had a mammogram. Overall, we found that 10 states had a 75th percentile of county prevalence estimate at 15.0% or more, or on average, one in seven women in this age group rarely or never had a mammogram. On a population level, these percentages translate into many age-eligible women not receiving a recent mammogram.

The disparity among counties is clearly depicted by the maps. The similarity between the two maps shows that many counties with the lowest estimated proportion of women being current with mammography had substantial proportions of women rarely or never having had a mammogram. Many of these counties are in rural areas, with low population density,[15] similar to the 2014 results,[7] and consistent with findings that rural women are less likely to have a current mammogram.[9,16–18] Issues with access to care, such as lack of insurance, lower mammography capacity, and lack of available medical personnel, may be more common in rural areas where a substantial proportion of the U.S. population lives[19] and may contribute to a disproportionately higher mortality rate.[19,20]

In addition, women in underserved areas or those who are inadequately screened may not have sufficient opportunities and information to correctly perceive and address their breast cancer risk[21,22]; this might be another reason for high numbers of women rarely or never having had a mammogram in these areas.

Lower screening test use increases the risk for more advanced disease at diagnosis.

Evidence-based approaches to promote screening might help reduce mammography screening gaps among counties. Mobile mammography, rather than fixed sites, has been used to increase access to screening in medically underserved areas. Mobile mammography delivered in local neighborhoods at low or no cost can also alleviate transportation cost and reduce screening gaps.[21] In addition, patient navigation as a part of mobile mammography programs has the potential to improve screening mammography completion and evaluation of any resulting abnormal mammograms.[22] To be most effective in addressing relevant barriers, programs can adopt practices that are culturally appropriate and tailored to the needs of local populations.[23,24] Our small area estimates can help states focus on areas of low screening prevalence that may benefit from interventions to increase screening uptake.

Limitations and strengths

Our study includes several limitations. First, our analysis depended on self-reported data on screening use, which were not verified with medical records. However, findings from studies on validity assessments indicated that BRFSS prevalence rates, when aggregated to a national level, were comparable with other national surveys relying on self-reports. Although some differences were observed for some response categories, these differences mostly had limited consequences for public health program implementation.[25,26]

Second, states' response rates for BRFSS vary and are relatively low. Nonresponse bias might exist among different geographic areas (*e.g.*, rural vs. urban) for mammography outcomes. However, we did not have enough survey metadata to evaluate it. Our small area estimation model, which included poststratification and county poverty rates, should have reduced this bias. It is possible that some adjacent counties with similar rural/urban areas have substantially different county-level mammography prevalence distributions. These differences might stem from various sources incorporated in our small area estimation model, such as state and county social, economic, cultural and policy differences specified by state-level random effects, county poverty, and county population composition differences by age, sex, and race and ethnicity. To better understand specific differences, further in-depth exploration about their socioeconomic, access to care, or program factors is needed.

Third, we excluded the category ‘‘other race’’ from our BRFSS analysis to match the race and ethnicity group variable to the U.S. Census respective variable. Lastly, estimates are based on any mammography use and not strictly screening mammograms. Strengths include the following: Our model generated data for all 3,142 U.S. counties, including those with missing samples for analysis with the BRFSS data, which are rarely available. Our multilevel regression and poststratification approach yielded state estimates, generated by aggregating their respective county estimates, which were highly correlated with the BRFSS state-specific estimates. In addition, our approach has been previously validated internally and externally for county-level estimates.[27] Estimates for public health districts with multiple counties can be generated by a population weight approach. For example, the estimate for a health district with three counties is (pop1*rate1+pop2*rate2+pop3*rate3)/(pop1+pop2+pop3), where pop_i and $rate_i$ are the population and prevalence of county i.

Prevalence about mammography use is available from the CDC Population Level Analysis and Community Estimates (PLACES)[28] project, which uses the same methodology as ours. PLACES provides online mapping and estimates at various geographic levels. However, PLACES county estimates might be slightly different from ours due to difference in the variables included in the multilevel small area models.

Conclusions

On average, our model-based estimates found that, in 2018, about three in four women were current with breast cancer screening according to the USPSTF recommendation. In addition, we found that one in nine women, on average, rarely or never had a mammogram, translating to more than 5 million women in the population. Many of these women resided in rural areas. Moreover, we identified marked disparities in mammography use across counties.

In addition to improving access to services, evidence-based efforts to promote screening use that are culturally appropriate and tailored to the needs of and barriers for local populations might help increase mammography uptake and reduce differences in mammography use among women.

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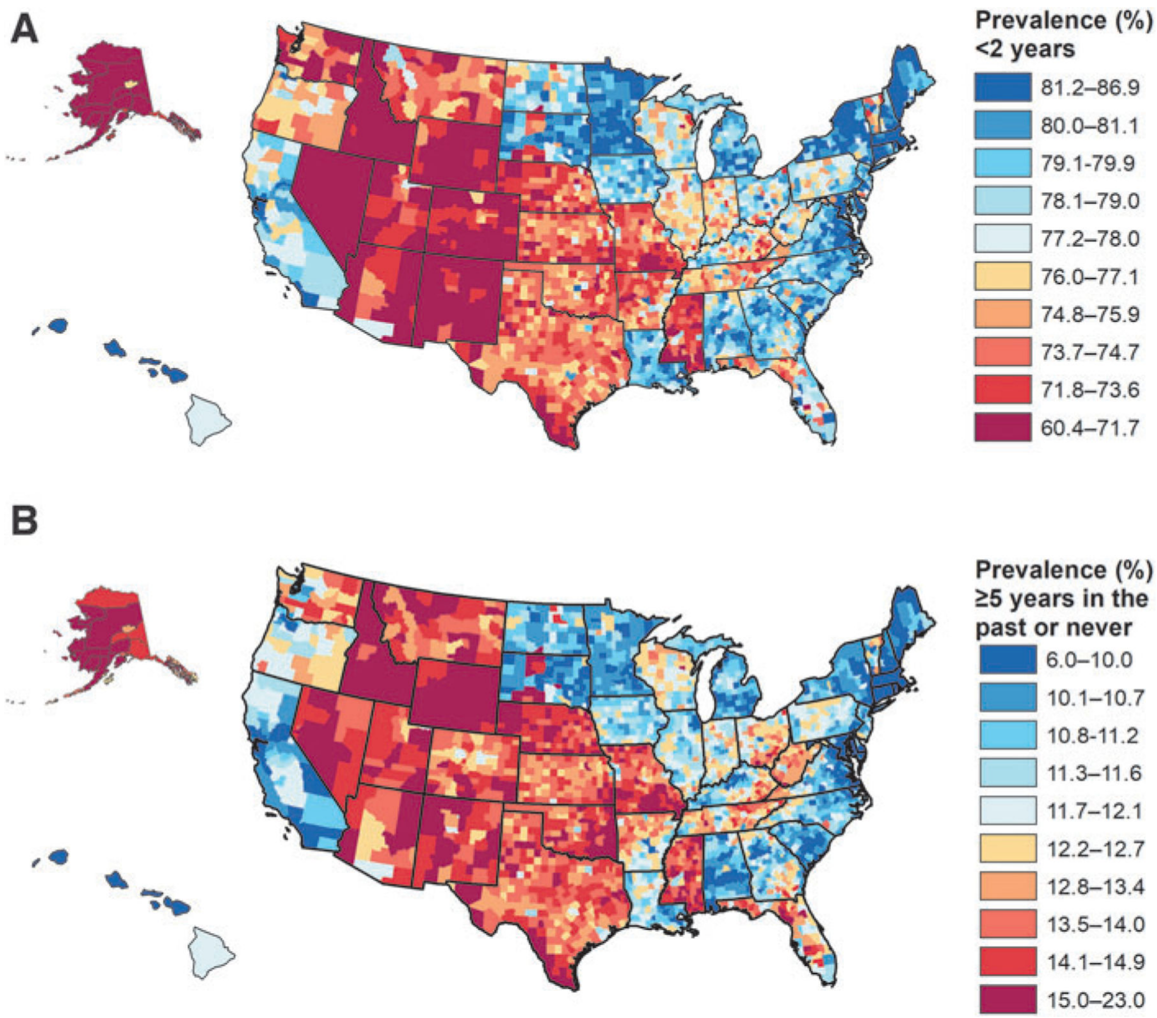

FIG. 1.

Model-based, county-level prevalence estimate (%) maps of two outcomes of mammography use using 2018 data: **(A)** Current (<2 years). **(B)** Rarely or never had a mammogram (most recent mammogram ≥5 years before the survey interview or never). The county percentage ranges shown on the *right* of each map differ by map. Percentage ranges for current mammography are in decreasing order. Percentage ranges for rarely or never are in increasing order. County-level mean estimates were aggregated by deciles, and a different color was assigned in the legend to each decile.

TABLE 1.

Comparisons of Model-Based National and State Summary Statistics Prevalence Estimates (%) with Direct Behavioral Risk Factor Surveillance System 2018 Prevalence Estimates (%) for Being Current with Mammography and Rarely or Never Having a Mammogram

Mammography	*Model-based*					*BRFSS*					*Timing*	
	National prevalence % (95% CI)					*National prevalence % (95% CI)*						
Current	78.7 (78.2–79.2)					78.7 (78.1–79.3)						
Rarely/never	11.0 (10.8–11.3)					10.9 (10.5–11.4)						
	States (51) summary statistics					*States (51) summary statistics*					*Correlation coefficient*	
	Mean	*Min*	*Median*	*Max*	*Range*	*Mean*	*Min*	*Median*	*Max*	*Range*	*Spearman*	*Pearson*
Current	78.0	69.4	78.7	84.8	15.4	77.8	66.9	78.1	86.8	20.0	0.96	0.96
Rarely/never	11.3	7.4	11.1	16.4	9.0	11.7	5.5	11.0	20.0	14.5	0.95	0.94
	Counties (3,142) summary statistics											
	Mean	*Min*	*Median*	*Max*	*Range*							
Current	76.7	60.4	77.1	86.9	26.5							
Rarely/never	12.3	6.0	12.1	23.0	16.9							

Notes: Current: <2 years; Rarely/never, ≥5 years or never having had a mammogram; Range, difference between maximum and minimum percentage.

BRFSS, Behavioral Risk Factor Surveillance System; CI, confidence interval; Max, maximum; Min, minimum.

TABLE 2.

Model-Based Small Area Estimation's State Mean Estimate (%) and County Statistics (%) Summarized by State for Being Current with Mammography and with Rarely or Never Having Had a Mammogram Using 2018 Data

	Current mammography								*Rarely or never*							
		County summary statistics								*County summary statistics*						
State	***State mean***	***Min***	***Q1***	***Mean***	***Median***	***Q3***	***Max***	***Range***	***State mean***	***Min***	***Q1***	***Mean***	***Median***	***Q3***	***Max***	***Range***
Alabama	80.7	75.0	78.0	79.4	79.2	80.7	85.3	10.3	9.8	8.0	39.8	10.4	4 10.4	11.1	12.7	4.7
Alaska	71.9	62.0	70.1	70.7	70.6	72.1	76.9	15.0	14.3	12.5	13.5	14.9	14.4	15.6	23.0	10.5
Arizona	73.5	65.1	67.0	70.4	70.	72.5	77.4	12.3	12.8	11.7	13.0	14.4	14.1	15.0	20.0	8.3
Arkansas	75.4	71.3	73.5	74.8	74.7	76.0	81.9	10.6	12.1	9.8	11.9	12.5	12.4	13.3	14.4	4.7
California	80.1	75.6	77.7	79.2	79.0	80.4	83.8	8.2	9.8	8.4	9.8	10.5	10.4	11.3	12.1	3.7
Colorado	73.1	66.1	69.8	71.0	71.1	72.3	76.7	10.5	12.7	11.3	12.8	13.6	13.7	14.4	16.5	4.8
Connecticut	83.3	78.8	80.6	82.2	82.2	83.2	86.7	7.9	7.6	6.0	7.5	7.9	8.3	8.5	8.7	2.7
Delaware	83.1	81.8	81.8	82.7	82.1	84.2	84.2	2.4	9.7	9.3	9.3	10.0	9.6	11.2	11.2	1.9
Washington DC	80.8			80.8					7.4			7.4				
Florida	78.5	70.5	75.2	77.0	77.2	78.8	82.4	11.8	12.0	10.5	11.9	12.9	12.7	14.0	15.8	5.4
Georgia	80.4	75.4	78.3	79.3	79.3	80.5	83.2	7.8	10.5	8.8	10.7	11.4	11.4	12.1	14.2	5.4
Hawaii	84.5	77.4	81.6	82.5	83.2	83.6	86.9	9.5	8.9	8.0	9.2	9.7	9.2	9.8	11.7	3.7
Idaho	69.4	62.3	66.4	67.9	67.8	69.3	72.3	9.9	16.4	14.0	15.9	16.6	16.6	17.3	20.4	6.5
Illinois	78.7	73.4	76.1	76.9	76.9	77.6	81.0	7.5	10.2	9.2	11.1	11.5	11.4	11.9	13.6	4.4
Indiana	76.9	72.2	75.8	76.6	76.8	77.4	79.7	7.5	11.7	10.2	11.5	11.9	11.9	12.4	13.4	3.1
Iowa	79.9	76.1	78.4	79.3	79.3	80.2	83.8	7.7	11.1	9.83	11.0	11.3	11.2	11.6	12.7	2.8
Kansas	74.8	69.8	72.6	73.9	74.1	75.1	78.7	8.9	13.0	10.8	13.1	13.6	13.5	14.3	15.8	5.0
Kentucky	78.5	70.7	76.0	77.2	77.3	78.6	82.5	11.8	10.9	8.94	10.8	11.6	11.5	12.4	14.7	5.7
Louisiana	81.1	77.3	78.9	79.9	79.6	80.9	85.0	7.7	10.5	9.09	10.7	11.2	11.4	11.8	12.9	3.8
Maine	81.5	77.7	79.2	80.9	81.4	82.2	83.5	5.8	9.1	7.08	9.0	9.6	9.7	10.7	11.3	4.2
Maryland	81.5	76.7	79.0	80.4	80.5	81.9	85.4	9.8	8.4	6.1	8.1	8.9	9.1	9.7	11.3	5.3
Massachusetts	84.8	80.8	83.4	84.3	84.6	85.9	86.7	5.9	7.7	6.93	7.6	8.0	8.0	8.4	9.1	2.2
Michigan	80.8	76.9	78.9	79.5	79.8	80.7	85.0	8.1	10.0	8.61	10.2	10.6	10.7	11.1	12.0	3.4
Minnesota	82.2	78.1	80.5	81.4	81.4	82.1	84.2	6.1	9.7	7.96	10.1	10.4	10.4	10.7	13.3	5.4
Mississippi	73.0	67.4	70.9	72.4	72.5	73.6	78.3	10.8	14.0	11.6	13.7	14.4	14.6	15.0	17.1	5.5

	Current mammography								Rarely or never							
		County summary statistics								County summary statistics						
State	***State mean***	***Min***	***Q1***	***Mean***	***Median***	***Q3***	***Max***	***Range***	***State mean***	***Min***	***Q1***	***Mean***	***Median***	***Q3***	***Max***	***Range***
Missouri	76.1	68.3	72.5	73.7	73.6	74.7	79.5	11.1	12.9	11.1	13.5	14.2	14.2	14.9	16.6	5.5
Montana	74.8	68.9	72.6	73.8	74.0	75.1	78.9	9.9	14.0	12.6	13.3	14.4	14.2	15.2	18.3	5.7
Nebraska	75.4	66.3	72.4	73.5	73.6	75.0	78.5	12.2	13.9	12.7	14.1	14.7	14.7	15.1	18.7	6.0
Nevada	70.6	63.5	66.9	68.5	68.4	70.8	71.7	8.2	14.7	13.5	14.3	15.1	14.8	15.8	16.8	3.3
New Hampshire	82.5	76.5	78.6	80.7	80.8	81.6	84.7	8.2	8.8	7.9	8.4	9.6	9.8	10.3	11.2	3.3
New Jersey	79.5	74.6	78.1	79.2	79.5	80.5	81.8	7.2	10.9	9.7	10.6	11.0	10.8	11.6	12.3	2.6
New Mexico	71.0	60.4	68.3	69.5	69.9	70.9	74.5	14.1	13.7	11.2	14.0	14.6	14.8	15.4	18.3	7.1
New York	82.1	76.3	80.1	81.2	81.5	82.6	84.9	8.5	9.4	8.1	9.7	10.2	10.3	10.7	12.4	4.3
North Carolina	79.9	76.8	78.4	79.5	79.5	80.5	82.5	5.6	10.8	9.4	10.5	11.1	11.0	11.6	13.5	4.1
North Dakota	79.7	70.2	77.3	78.3	78.5	79.6	82.6	12.4	10.6	9.2	10.5	11.1	10.8	11.2	17.2	8.0
Ohio	78.9	73.3	77.5	78.2	78.3	79.5	82.6	9.3	12.1	10.0	11.9	12.5	12.4	12.9	15.6	5.6
Oklahoma	75.5	70.4	73.5	74.6	74.5	75.4	81.5	11.1	13.7	11.3	13.6	14.4	14.4	15.1	17.5	6.2
Oregon	77.8	73.0	75.2	76.4	76.2	77.2	83.1	10.1	11.1	9.6	11.3	11.7	11.8	12.3	13.4	3.8
Pennsylvania	79.0	75.2	77.1	78.0	77.8	78.9	81.4	6.2	10.9	9.4	11.0	11.5	11.6	12.0	12.7	3.3
Rhode Island	83.6	79.1	81.8	82.7	83.7	84.4	84.6	5.5	7.9	7.3	8.3	8.5	8.5	9.0	9.	2.0
South Carolina	79.2	75.2	78.3	79.3	79.3	80.5	83.6	8.4	10.2	8.2	9.8	10.3	10.3	10.9	12.0	3.8
South Dakota	80.5	66.9	79.3	79.6	80.5	81.3	85.9	19.0	10.4	8.5	9.9	11.1	10.2	11.1	19.2	10.7
Tennessee	76.9	2.0	74.3	75.7	75.4	76.7	80.8	8.8	12.0	10.1	12.2	12.9	12.9	13.6	15.2	5.1
Texas	75.2	66.4	73.5	74.4	75.5	75.3	80.0	13.6	13.3	11.5	13.3	13.8	13.8	14.3	17.3	5.8
Utah	73.0	66.1	70.4	72.1	72.3	74.1	77.5	11.4	13.9	12.0	13.7	14.4	14.2	14.8	17.6	5.6
Vermont	77.5	72.8	74.0	76.7	76.5	78.6	81.6	8.8	11.3	9.9	10.5	11.6	11.8	12.4	13.6	3.8
Virginia	81.0	74.2	79.0	80.0	80.2	81.5	84.1	10.0	10.2	8.7	10.0	10.9	10.8	11.7	14.1	5.4
Washington	75.1	64.9	70.0	72.5	72.5	75.6	76.9	12.0	11.5	10.3	12.1	12.7	12.6	13.8	14.7	4.4
West Virginia	78.0	74.7	76.2	77.5	77.4	78.6	81.1	6.5	12.7	10.9	12.4	13.0	12.9	13.4	14.9	4.1
Wisconsin	78.2	69.9	76.5	77.4	77.8	78.6	80.7	10.8	11.7	10.2	11.6	12.1	12.1	12.5	17.1	6.9
Wyoming	71.0	66.5	68.3	70.1	69.9	71.7	75.2	8.7	16.1	14.3	15.5	16.4	16.7	17.2	18.1	3.8

Notes: Up to date, <2 years; Rarely/never, ≥5 years or never having had the mammogram; Range, difference between maximum and minimum percentage.

Q1, 25th percentile; Q3, 75th percentile; SAE, small area estimation.