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Trends in Mammography Usage Among Women Aged 30-44 in the United States From 2000-2018

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Bachelor of Arts
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Abstract

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By Jeremy Johnson

Technological innovation in breast cancer screening and interventions has led broad improvement in the morbidity and mortality. However, variations in professional guidelines, increasingly diverse patient populations, and an evolution of our understanding in risk underlie difficulties in providing individual guidance for when to begin breast cancer screening. Additionally, several past studies have demonstrated potential overuse of mammography among younger patient populations for whom there is limited benefit for the associated patient risk. Furthermore, there has been little investigation into rates of mammography usage in younger women over time. This analysis investigates study prevalence and trends in mammography usage in women aged 30-44 in the US from 2000 to 2018. Self-reported data from eight National Health Interview Surveys (NHIS) conducted between 2000-2018 was used to estimate the prevalence of ever having had a mammogram as well as having had a mammogram in the past year during each survey year. We observed significantly decreased adjusted prevalence rate ratios (aPRR) of ever having a mammogram among women aged 34-39 during 2015 (0.456 95%CI: 0.407-0.511) and 2018 (0.408 95%CI:0.359-0.463) when compared with the same age group from 2000 (0.564 95%CI:0.525-0.605) and 2003 (0.580 95%CI: 0.539-0.624). This change is largely driven by year over year changes with significantly decreased utilization among non-Hispanic White women in 2010/2013 (0.784 95%CI: 0.709-0.868) and 2015/2018 (0.619 95%CI: 0.548-0.698) when compared with the same group in 2000/2003. Our population analysis of NHIS US population survey data between 2000-2018 shows nationwide declines in mammogram utilization in women aged 30-39 with more mammography occurring in certain subpopulations with historically worse breast cancer outcomes.

Keywords: Mammography, Breast Cancer, Screening, Health Equity, Population Survey Analysis, Prevalence Rate Ratio.

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Introduction

In the United States in 2019, the observed SEER incidence of breast cancer among women aged 15-39 was 24 per 100,000 women with a mortality rate in the same group of 2.4 per 100,000[1]. While significant declines in mortality among women with breast cancer have been realized over the past 30 years, since 2010 mortality rates have stabilized and even begun to increase slightly. However, disparities in outcomes are evident over this period. For instance, during 2010-2014 mortality rates due to breast cancer among black women were 41% higher than white women over the same period. Additionally, when examining morbidity and mortality trends by race and age, evidence shows the decline in mortality due to breast cancer was reduced in black women over the age of 50[2].

For average risk women, screening mammography consists of a 2-view x-rays of the breast at regular intervals. The first trial of breast cancer screening in the US occurred in 1963 as part of the Health Insurance Plan in New York[3]. Despite a complicated history of mammography as a screening tool for early detection of breast cancer[4,5], current evidence suggests the benefits associated with early detection in certain age groups provides more benefit than harm[6-10]. Early detection and intervention are associated with better patient outcomes. Expert advice is nearly unanimously in favor of routine mammography screening in average risk women. However, different societies and professional organizations offer a multitude of guidelines for when to begin such screening and how frequently it should occur. Furthermore, these guidelines have changed over time to reflect new data and technological advance in screening technologies.

Major societal organizations offering recommendations for screening include the American Cancer Society (ACS), United States Preventative Services Task Force (USPSTF), National Comprehensive Cancer Network (NCCN), American Academy of Family Physicians (AAFP), American College of Radiology (ACR) and American College of Obstetricians and Gynecologists (ACOG). The range of different organizations offering

guidelines is reflective of an even broader set of recommendations and practices throughout the medical field. For instance, where ACS and USPSTF had issued recommendations for clinical breast exams and self-breast examinations in average-risk women during the early 2000s[11,12], evidence since that time has not shown any benefit in the practice and BSE and CBE have since declined[13,14]. Current ACS guidelines recommend personalized decision making for 40–44-year-old women, annual mammograms for women 45-54, and biennial screenings for women 55+[15]. Since 2009, the USPSTF recommends biennial screenings for women 50-74 with personalized decision making from 40-49[16]. This contradicts USPSTF recommendations made in 2002 for 1–2-year routine screening beginning at age 40. The variability in recommendations extends across professional organizations and is subject to revision that makes consistent care and consultation for patients highly variable between providers[17].

For patients under 45 years old, the criteria for screening are less concrete. Currently, there are no major organizations that recommend routine mammography for average-risk women under the age of 40. Diagnosis of breast cancer in this patient population has been associated with significant risk of recurrence and has been shown to be an independent prognostic factor for survival[18-20]. In response, ACS, NCCN, and the ACR among others have made recommendations to start screening high-risk patients in their 30s[21-23]. What effect these recommendations for individualized screening have had on mammography rates in this population remains a question. Furthermore, recent evidence suggests that the incidence of breast cancer is rising among women under the age of 40[25,26] and that waiting to screen high-risk women until age 40 may result in worse outcomes due to delayed diagnoses and more aggressive subtypes[27,28]. In response to these recent findings, some have suggested alternative, more proactive screening recommendations.[29].

Determining the most effective balance between early diagnosis of breast cancer and avoiding undue harm from over-screening presents a challenge. Overdiagnosis is defined as the diagnosis of breast cancer based on physiologic findings that may have no malignant potential. Without the ability to differentiate malignant tumors from benign physiology on x-ray, women undergoing routine mammography will be

subject to interventions without benefit. Some data suggests that in the US, after 10 years of annual screening, more than half of women will receive at least one false-positive recall and 7-9% will receive a false-positive biopsy recommendation[30]. Because there is a lower rate of breast cancer in younger women, we can expect that the incidence of false positive findings will be even higher in this subgroup.

Screening prevalence data for women above age 45 is widely available. However, there is much less published material that examines the screening prevalence in younger patient populations despite an estimated 24 cases per 100,000 women aged 15-39 diagnosed in 2019. This research aims to better understand the prevalence of ever having a mammogram among US women aged 30-44, the prevalence of routine annual mammography in the same population, and Socio-economic as well as demographic trends in the utilization of mammography within this population over time.

Materials and Methods

This study used publicly available survey data from the National Health Interview Survey (NHIS) data repository extracted with from IPUMS Health Surveys: NHIS (https://www.nhis.ipums.org)[31]. NHIS is a principal source of health information from non-institutionalized US citizens and is a primary data source for the National Center for Health Statistics (NCHS). NIHS data are collected continuously throughout a given survey year using computer-assisted personal interview to survey, on average, 100,000 people from 45,000 households in the US using geographically clustered sampling techniques. IPUMS Health Surveys: NHIS is a database of 50 years of NHIS data and variables available for curation and analysis.

Our analyses involved IPUMS NHIS data extraction from 2000-2018 (2000, 2003, 2005, 2008, 2010, 2013, 2015, 2018). These are contiguous survey years during which the variables and covariates of interest were available in all survey data. Variables of interest include individual year, mammography history, year of last mammogram, age, race/ethnicity, geographic region, educational attainment, income, healthcare access, and insurance coverage. Domain analyses involved only those observations with complete data

for age, race, ethnicity, region, educational attainment, income, and healthcare coverage for each individual person observation.

Statistical analyses involved determination of population prevalence based on weighting of cluster-correlated study design and Taylor series linearization of variance. We used SAS (SAS 9.4 TS Level 1M6, SAS Institute, Cary North Carolina) surveyfreq and surveymean procedures for sample analysis, prevalence estimates, and domain analyses. We used SUDAAN (Research Triangle Institute, Research Triangle Park, North Carolina) rlogist functions to fit population-weighted logistic regression models and obtain adjusted prevalence rate ratios (aPRR), standard errors and confidence intervals.

Results

Table 1 statistics demonstrate sample population characteristics that meet inclusion criteria. Mean population age across years is 35.6(SD=3.97) and did not change over time (p=0.2). Population sample is 58.5% non-Hispanic White, 16.5% non-Hispanic Black, and 25.0% Hispanic. Geographic distribution is 15.6% located in the Northeast, 22.2% located in the Midwest/Central, 36.7% located in the South, and 25.5% located in the United States West. 13.5% of the sample have not completed a high school education or equivalent, 24.4% of the sample completed a high school education or the equivalent, 31.2% of the population completed less than four years of college. And 31.0% of the sample population completed four or more years of college. Trends in distribution within variable classes remained similar throughout the period under review.

Among women having a receipt of mammogram for any reason, weighted population prevalence estimates differed significantly between years for age groups ($p<0.001$). There were no significant differences between years among women in the 30-34-year-old cohort (p=0.09) (Table 2).

In the 34–39-year-old age group the following comparisons reached statistical significance. Compared to 2018, the prevalence of 29.1 (95%CI: 26-32.2) was greater in 2000, 2003, 2005, 2008, and 2010 [41.8(95%

CI: 39.3-44.3), 43.6(95%CI: 41.0-46.2), 39.1(95%CI: 36.3-41.9), 40.1(95%CI: 36.9-43.3), and 35.5(95%CI: 32.6-38.3), respectively]. Compared to 2015, the prevalence of 29.5 (95%CI: 26.6-32.5) was greater in 2000, 2003, 2005, 2008, and 2010. Compared to 2013, the prevalence of 33.5 (95%CI: 30.7-36.3) was greater in 2000, 2003, and 2008 [41.81(95% CI: 39.3-44.3), 43.6(95%CI: 41.0-46.2), and 40.1(95%CI: 36.9-43.3), respectively]. Compared to 2010, the prevalence of 35.5 (95%CI: 32.6-38.3) was greater in 2000 [41.8 (95%CI: 39.3-44.3)].

In the 40-44-year-old age group the following comparisons reached statistical significance. Compared to 2018, the prevalence of 67.5 (95%CI: 64.4-70.6) was greater in 2000, 2003, and 2008 [73.4 (95%CI: 71.6-75.7), 73.4(95%CI: 71.0-75.1), and 74.4 (95%CI: 71.3-77.5), respectively]. Compared to 2015, the prevalence of 65.7 (95%CI: 62.8-68.7) was greater in 2000, 2003, 2005, 2008, and 2010[73.4 (95%CI: 71.6-75.7), 73.4(95%CI: 71.0-75.1), 72.6 (95%CI: 70.2-75.1), 74.4 (95%CI: 71.3-77.5), and 72.4 (95%CI: 69.5-75.4), respectively].

Among women having receipt of mammogram in the previous 12 months from the data of the survey, we observed significant differences in the 35-39-year-old ($p=0.046$) and 40-44-year-old ($p<0.001$) cohorts. There were no significant differences between years among women in the 30–34-year-old cohort ($p=0.5$) (Table 3).

In the 34-39-year-old age group, compared to 2005, the prevalence of 6.3(95%CI: 1.9-10.8) was greater in 2000 and 2003 [28.5 (95%CI: 22.6-34.5) and 23.9 (95%CI: 18.5-29.3), respectively]. In the 40–44-year-old age group, compared to 2013, the prevalence of 6.4 (95%CI: 2.7-10.1) was greater in 2000, 2003, 2005, 2008, 2010, and 2018[28.5 (95%CI: 22.6-34.5), 23.9 (95%CI: 18.5-29.3), 19.2 (95%CI: 12.8-25.6), 16.4 (95%CI: 10.9-21.8), 18.8 (95%CI: 12.4-25.1), and 20.9 (95%CI: 13.2-28.6), respectively].

Estimated prevalence of receipt of mammogram at any time and having had a mammogram in the past year suggest that there are significant differences between all three age groupings (30-34: 15.391 95%CI:

14.7 - 16.0 vs. 35-39: 28.8 95%CI: 27.9-29.6 vs. 40-44: 55.9 95%CI: 55.0-56.7). There are also significant differences between the prevalence of ever having had a mammogram and receipt of mammogram for any reason among non-Hispanic Black, non-Hispanic White and Hispanic patients (78.6 (95%CI: 78.1-79.1) vs. 12.3 (95%CI: 11.9-12.7) vs. 9.1 (95%CI: 8.8-9.4)). Cumulative characteristics of women who have mammograms from 2000 to 2018 suggest significant differences between geographic regions (Northeast: 19.0 95%CI: 18.6-19.5, Midwest: 23.8 95%CI: 23.3-24.3, South: 36.9 95%CI: 36.3-37.5, West: 20.2 95%CI: 19.7-20.7). There is a significantly lower likelihood of women who have not completed high school and those who have completed four or more years of college vs. women with high school diplomas (12.2 95%: 11.9-12.5 / 27.9 95%: 27.4-28.4 vs. 30.1 95%: 29.7-30.6). Across years, women who have ever had a mammogram are more likely to have health insurance coverage [92.86 (95% CI: 92.65-93.07) vs. 7.14(95% CI: 6.93-7.35) and 95.09(95% CI: 94.20-95.99) vs. 4.91(95% CI: 4.01-5.80) for Covered vs. uncovered and ever having had a mammogram vs. having had a mammogram in the past 12 months). Additionally, there is a positive association between income and prevalence of having had a mammogram as well as mammogram in the pas year [11.97 (95%CI: 11.63-12.31), 18.58 (95% CI: 18.18-18.97), 69.46 (95% CI: 68.93-69.99) and 12.81 (95% CI: 11.37-14.25), 19.19 (95%CI: 17.41-20.96), 68.00(95% CI: 65.88-70.12) for income ratios below 1, 1-2, and >=2 respectively and grouped by ever having mammogram and mammogram in the past year].

Estimations of population weighted prevalence rate ratio of ever having a mammogram in women aged 35-39 showed significant decline from 2000, 2003, 2005, and 2008 to 2018 [aPRRs 0.564(95%CI: 0.525-0.605), 0.580(95%CI: 0.539-0.624), 0.534(95%CI:0.486-0.588), and 0.534(95%CI: 0.486-0.588) vs. 0.408(95%CI: 0.359-0.463), respectively] (Table 5). A similar result is seen between the years 2015 and 2000/2003 [aPRRs 0.456(95%CI: 0.407-0.511) vs. 0.564(95%CI: 0.525-0.605) and 0.580(95%CI: 0.539-0.624) respectively]. There were no significant differences between years in the adjusted prevalence rate

ratio of women aged 30-34 for any year comparisons within 2000 to 2018. We observed no significant difference in the aPRR of having had a mammogram in the past 12 months over the time examined.

To better understand the changes in PRR between age groups from 2000-2003 to 2015-2018 we conducted additional adjusted prevalence rate ratios comparing within age groups and across biennial years (Table 6-10). For non-Hispanic Black women, we found a significantly elevated aPRR of 1.530 (95%CI: 1.216-1.924) for ever having had a mammogram in 30–34-year-old women when comparing 2010-2013 with 2000-2003 of. This is in stark contrast to trends in aPRR of having receipt of mammogram for non-Hispanic White women and Hispanic women aged 34-39 in 2010-2013 (0.784 95%CI:0.709-0.868 and 0.809 95%CI: 0.681-0.960) respectively). Additionally, in the same age group, there was a significant decline in PRR comparing years 2015-2018 with 2000-2003 in non-Hispanic White and Hispanic women (aPRR 0.619 95%CI: 0.548-0.698 and 0.701 95%CI: 0.573-0.857).

Discussion

The purpose of this study was to understand the utilization of mammography in women under 40 years old. Our results suggest that there has been significant change in the rate at which young women have been screened for mammograms since the year 2000. While there has been a general decline in the number of mammograms for women aged 34-39, there has been an increasing trend, albeit insignificant in women aged 30-34 over the same period (figure 1). This data shows an apparent convergence of the aPRR between 30-34 and 35-39 from 2000 to 2018. With no definitive guidelines for average-risk patients under 40, clinicians are tasked with understanding the individual risk profile for their patients. Better patient education, shared decision making, and risk counseling may underlie why more 30-34 and fewer 35-39 women have received mammograms from 2000-2018. Assuming more individualized screening recommendations across the 30–40-year-old demographic has produced more homogeneity over time,

understanding the factors that precipitated the initial divergence between 30-34-year-olds and 35–39-year-old populations warrants further investigation.

However, an alternative explanation may be that the 34–39-year-old age group has seen a decline to a rate more commonly seen in 30–34-year-old patients for whom no significant changes have occurred over time. While possible, recent trends towards value-based healthcare, more personalized medical care and prioritization of prevention over treatment would suggest that the changes seen here reflect administrative and philosophical changes in healthcare delivery.

To address the changes seen in prevalence rate ratio of ever receiving a mammogram between age groups, we estimated additional aPRRs comparing within age groups and ethnic subpopulations across years arranged as biennial pairs. From this analysis we find that aPRR estimates generally tend to decline when comparing biennial pairs with 2000/20003 estimates. Particularly among white women in the 35–39-year-old and 40-44 year-old subgroups as well as in 30-39 year-old Hispanic subgroup when comparing 2010-2013 and 2015-2018 couplets.

Changes within subgroups likely reflect the changing recommendations for mammograms. Evidence for more aggressive cancer arising in younger patients has understandably encouraged physicians to council their patients regarding their individual risk for breast cancer. Likewise, unbiased and complete conversations with patients regarding the risks and benefits associated with mammography has tempered the popular sentiment for more testing. Further investigations should stratify patient populations by risk of breast cancer to determine the influence of this variable on population prevalence.

We found that the trend within the 30–34-year-old non-Hispanic Black subgroup differed from both other ethnic groups across all years and other age groups within the non-Hispanic Black population across all comparisons. APRRs were greater than one in all pairwise comparisons with 2000-2003 couplet for 30–34-year-old non-Hispanic Black women (1.265 95%CI: 0.972-1.646, 1.530 95%CI: 1.216-1.924, 1.174

95%CI: 0.896-1.540 for 2005/2008, 2010/2013, and 2015/2018 respectively). These results suggest that the rate of having receipt of mammogram for any reason following 2000-2003 year was higher non-Hispanic Black women. This differs from the trend seen across other age groups and other examined ethnicities where aPRR where generally less than one and showed a decreasing trend while remaining insignificant. Additionally, from table 2 we see that the proportion of women reporting having ever had a mammogram among non-Hispanic Black and Hispanic women has improved from 2000-2018 (66.8 and 60.2 to 75.8 and 68.9, respectively), though these proportions have not reached the prevalence of mammograms in the non-Hispanic White patient population. These changes may reflect growing awareness of inequity in screening these populations. Specifically young black women. We hypothesize that reflexive changes in response to new evidence of fewer diagnoses, worse outcomes, and more aggressive cancers in this group may lead providers to begin screening sooner in this patient populations while remaining judicious with screening recommendations[32-34].

Limitations

The data analyzed in this study are limited to available survey data from the NHIS. While NHIS accounts for some response bias seen in survey data, it is impossible to completely discount this effect from the results observed. Evidence suggests that national survey data may overestimate cancer-screening utilization while minimizing disparities in screening[35]. Additionally, variables of interest were not collected uniformly across all survey years assessed. Therefore, our analysis lacks further investigation into the underlying risk attributable to each patient. Evidence also suggests that a patient's provider and the clinical society guidelines from which their practice patterns are based, influence the frequency and initiation of screening mammography. Future population studies should examine the physician resource from whom patients receive their screening guidance.

Conclusion

This population analysis analyzed NHIS US citizen response data to estimate prevalence of mammography among women aged 30-44 from 2000-2018. Our findings suggest that the rate of mammography among women aged 34-39 has declined over this period. Additionally, we have found that the decline is not uniform among socio-economic and ethnic segments of the US population.

TABLE 1. Eligible NHIS Sample Participant Demographics, 2000-2018

	2000	2003	2005	2008	2010	2013	2015	2018	Total
	n=2696	n=2363	n=2221	n=1670	n=2106	n=2837	n=2665	n=1930	n=18488
Age(mean, SD)	35.73(4.02)	35.51(4.00)	35.56(3.97)	35.69(4.00)	35.62(3.95)	35.55(3.90)	35.66(4.02)	35.81(3.92)	35.64(3.97)
Race count(%)									
Non-Hispanic white	1649(61.16)	1375(58.19)	1329(59.84)	947(56.71)	1092(51.85)	1560(54.99)	1581(59.32)	1273(65.96)	10806(58.45)
Non-Hispanic black	457(16.95)	406(17.18)	344(15.49)	299(17.90)	385(18.28)	492(17.34)	398(14.93)	277(14.35)	3058(16.54)
Hispanic	590(21.88)	582(24.63)	548(24.67)	424(25.39)	629(29.87)	785(27.67)	686(25.74)	380(19.69)	4624(25.01)
Geography count(%)									
Northeast	493(18.29)	404(17.10)	336(15.13)	244(14.61)	283(13.44)	426(15.02)	421(15.80)	283(14.66)	2890(15.63)
Midwest	638(23.66)	531(22.47)	539(24.27)	394(23.59)	443(21.04)	540(19.03)	562(21.09)	457(23.68)	4104(22.20)
South	939(34.83)	849(35.93)	800(36.02)	623(37.31)	828(39.32)	1089(38.39)	944(35.42)	708(36.68)	6780(36.67)
West	626(23.22)	579(24.50)	546(24.58)	409(24.49)	552(26.21)	782(27.56)	738(27.69)	482(24.97)	4714(25.5)
Education count(%)									
No Highschool Diploma	391(14.5)	342(14.47)	320(14.41)	232(13.89)	327(15.53)	372(13.11)	331(12.42)	172(8.91)	2487(13.45)
Highschool Diploma	831(30.82)	629(26.62)	606(27.29)	428(25.63)	473(22.46)	615(21.68)	555(20.83)	367(19.02)	4504(24.36)
<4 years of college	808(29.97)	765(32.37)	671(30.21)	535(32.04)	673(31.96)	922(32.5)	859(32.23)	541(28.03)	5774(31.23)
4+ years of college	666(24.70)	627(26.53)	624(28.10)	475(28.44)	633(30.06)	928(32.71)	920(34.52)	850(44.04)	5723(30.96)
Income ratio of Federal Poverty Ratio count (%)									
<1	437(16.21)	401(16.97)	407(18.33)	311(18.62)	507(24.07)	657(23.16)	585(21.95)	276(14.30)	3581(19.37)
1-2	558(20.70)	531(22.47)	464(20.89)	353(21.14)	439(20.85)	610(21.50)	586(21.99)	345(17.88)	3886(21.02)
>=2	1701(63.09)	1431(60.56)	1350(60.78)	1006(60.24)	1160(55.08)	1570(55.34)	1494(56.06)	1309(67.82)	11021(59.61)
Insured count(%)									
Covered	*2148(79.67)*	1812(76.68)	1709(76.95)	1290(77.25)	1565(74.31)	2115(74.55)	2199(82.51)	1678(86.94)	14516(78.52)
Uncovered	548(20.33)	551(23.32)	512(2305)	380(22.75)	541(25.69)	722(25.45)	466(17.49)	252(13.06)	3972(21.48)

Table 2. Predicted Population Prevalence of Ever Having Receipt of Mammogram For Any Reason, 2000-2018

	2000			2003			2005			2008			2010			2013			2015			2018		
	Prevalence %	95% CI		Prevalence %	95% CI		Prevalence %	95% CI		Prevalence %	95% CI		Prevalence %	95% CI		Prevalence %	95% CI		Prevalence %	95% CI		Prevalence %	95% CI	
Age																								
30-34	17.9	15.9	19.9	18.8	16.5	21.1	19.1	16.9	21.3	20.7	17.9	23.6	19.9	17.3	22.5	19.8	17.6	22.0	17.2	14.9	19.5	19.9	17.3	22.5
35-39	41.81	39.34	44.27	43.6	41.02	46.2	39.1	36.3	41.9	40.1	36.9	43.3	35.5	32.6	38.3	33.5	30.7	36.3	29.5	26.6	32.5	29.1	26	32.2
40-44	73.44	71.16	75.71	73.44	71.0	75.1	72.6	70.2	75.1	74.4	71.3	77.5	72.4	69.5	75.4	71.2	68.6	73.8	65.7	62.8	68.7	67.5	64.4	70.6
Race																								
Non-Hispanic White	74.6	73.6	75.6	76.1	75.0	77.2	77.6	76.6	78.6	79.8	78.7	80.9	80.8	79.8	81.9	80.5	79.6	81.5	80.4	79.3	81.4	81.2	80.3	82.2
Non-Hispanic Black	66.8	64.5	69.1	68.4	66.3	70.6	69.2	66.7	71.7	74.3	71.8	76.7	73.9	71.7	76.0	74.5	72.5	76.5	74.3	71.9	76.6	75.8	73.4	78.2
Hispanic	60.2	57.8	62.6	60.2	57.8	62.6	58.3	55.7	60.9	64.9	62.2	67.6	65.3	63.0	67.6	64.2	62.3	66.2	64.3	62.0	66.6	68.9	66.0	71.9
Geography																								
Northeast	73.2	71.1	75.2	75.1	73.3	76.9	76.7	75.1	78.3	79.4	77.4	81.3	80.4	78.5	82.3	79.5	77.5	81.5	78.3	76.4	80.2	79.9	77.9	81.9
Midwest	71.8	69.9	73.6	74.6	72.9	76.2	75.5	73.7	77.3	76.7	74.7	78.7	77.7	75.7	79.7	77.4	75.5	79.2	77.4	75.9	78.9	78.1	76.2	79.9
South	71.9	70.7	73.2	72.5	71.0	74.1	73.7	72.2	75.2	76.4	74.8	78.0	77.8	76.5	79.2	76.9	75.5	78.2	77.0	75.6	78.5	78.4	76.7	80.1
West	70.7	68.5	72.8	70.9	68.6	73.3	71.7	69.7	73.7	77.0	75.2	78.8	75.9	74.1	77.8	75.7	73.9	77.5	75.4	73.4	77.4	75.9	74.2	77.6
Education																								
No Highschool Diploma	70.0	68.1	71.9	69.6	67.7	71.5	71.0	68.8	73.2	74.1	71.5	76.7	73.4	71.1	75.8	73.9	71.8	76.0	73.4	70.9	75.8	74.5	71.4	77.7
Highschool Diploma	72.8	71.4	74.2	74.5	73.1	75.9	75.8	74.3	77.2	79.5	77.8	81.2	80.9	79.6	82.3	80.4	78.9	81.8	79.8	78.3	81.4	81.9	80.3	83.4
<4 years of College	72.3	70.7	73.9	74.2	72.7	75.7	75.0	73.5	76.5	76.5	74.8	78.2	78.7	77.2	80.3	77.0	75.6	78.5	78.3	76.8	79.7	81.1	79.7	82.5
4+ years of College	71.3	69.5	73.2	72.6	70.8	74.4	74.1	72.6	75.6	76.9	74.8	78.9	75.7	74.0	77.4	75.7	74.2	77.1	74.8	73.2	76.3	73.7	72.2	75.2
Income ratio of Federal Poverty Ratio																								
<1	62.6	60.0	65.1	64.3	61.6	67.1	62.6	59.5	65.6	67.9	64.7	71.1	66.8	64.3	69.3	66.9	64.7	69.0	68.2	65.8	70.5	70.7	67.7	73.6
1-2	68.3	66.1	70.4	67.7	65.5	69.8	72.1	70.2	74.0	72.0	69.7	74.4	73.9	72.0	75.9	74.7	72.8	76.5	73.7	71.8	75.6	77.9	76.0	79.8
>=2	72.9	71.6	74.1	75.1	73.8	76.4	76.1	74.9	77.2	79.4	78.2	80.5	80.3	79.1	81.4	79.2	78.2	80.2	79.3	78.3	80.4	78.9	77.8	79.9
Insured																								
Covered	74.6	73.7	75.5	76.1	75.3	77.0	77.3	76.4	78.2	79.4	78.5	80.4	80.8	79.9	81.7	80.3	79.5	81.1	79.2	78.4	80.1	79.7	78.8	80.6
Uncovered	49.1	46.6	51.7	50.7	48.0	53.3	50.5	47.8	53.2	58.3	55.1	61.6	56.2	53.7	58.8	54.3	52.0	56.6	48.2	44.8	51.6	57.0	52.8	61.2

Table 3. Estimated Population Prevalence of Having Received a Mammogram in the Past 12 Months, 2000-2018

	2000			2003			2005			2008			2010			2013			2015			2018		
	Prevalence %	95% CI		Prevalence %	95% CI		Prevalence %	95% CI		Prevalence %	95% CI		Prevalence %	95% CI		Prevalence %	95% CI		Prevalence %	95% CI		Prevalence %	95% CI	
Age																								
30-34	20.8	11.2	30.4	8.6	2.7	14.5	15.5	6.2	24.8	13.4	0.6	26.1	13.0	3.8	22.2	7.2	1.4	13.0	5.1	0	10.4	5.2	0	10.8
35-39	15.5	11.0	20.0	16.8	11.2	22.4	6.3	1.9	10.8	10.6	1.0	20.1	10.1	5.5	14.7	12.4	7.5	17.2	14.0	6.9	21.0	15.9	4.8	27.0
40-44	28.5	22.6	34.5	23.9	18.5	29.3	19.2	12.8	25.6	16.4	10.9	21.8	18.8	12.4	25.1	6.4	2.7	10.1	16.0	9.2	22.7	20.9	13.2	28.6
Race																								
Non-Hispanic White	26.8	24.4	29.3	29.2	26.6	31.7	21.4	18.6	24.2	18.2	15.2	21.2	18.3	15.4	21.1	11.7	9.8	13.6	13.9	12.0	15.9	15.8	13.7	18.0
Non-Hispanic Black	30.3	23.5	37.1	40.1	32.3	48.0	28.1	19.3	36.9	26.5	17.4	35.7	27.0	20.2	33.9	15.2	11.4	18.9	24.5	17.4	31.6	23.4	16.6	30.2
Hispanic	38.2	29.2	47.1	31.5	24.3	38.8	24.8	14.9	34.7	24.1	15.5	32.7	32.5	25.3	39.6	14.4	9.8	19.1	16.3	11.2	21.3	19.9	12.8	26.9
Geography																								
Northeast	24.9	19.8	29.9	30.8	25.8	35.8	26.5	18.9	34.2	22.9	15.9	29.8	21.3	14.4	28.2	13.4	9.7	17.0	18.4	13.6	23.2	22.0	16.2	27.7
Midwest	27.4	24.2	30.5	29.7	26.1	33.4	18.8	14.1	23.4	17.5	12.4	22.5	14.5	11.2	17.9	11.0	7.5	14.4	12.5	9.6	15.4	17.9	13.9	21.9
South	30.1	25.9	34.3	30.3	26.1	34.4	23.8	18.2	29.5	17.5	12.9	22.1	20.9	17.2	24.7	12.1	9.4	14.8	15.3	12.4	18.3	12.6	9.5	15.7
West	28.2	21.9	34.5	29.0	22.8	35.3	22.9	19.3	26.4	22.0	16.1	28.0	27.5	21.8	33.1	13.2	9.9	16.5	16.4	12.0	20.8	18.6	14.7	22.5
Education																								
No Highschool Diploma	28.9	23.7	34.1	29.5	24.2	34.9	16.4	11.2	21.6	17.8	11.9	23.6	23.1	18.2	28.0	11.5	7.7	15.2	18.4	13.7	23.1	13.8	8.8	18.8
Highschool Diploma	28.8	25.1	32.5	32.3	28.1	36.6	23.6	19.6	27.6	17.8	13.4	22.2	21.0	17.0	25.0	12.6	9.8	15.4	14.4	11.1	17.7	15.4	11.9	18.8
<4 years of College	23.5	19.3	27.8	28.5	23.8	33.1	21.3	16.7	25.8	18.5	13.6	23.4	19.6	15.8	23.4	12.4	9.7	15.2	13.8	10.9	16.7	18.1	14.7	21.4
4+ years of College	29.7	25.0	34.4	27.8	23.4	32.2	26.5	20.6	32.3	24.7	18.2	31.2	22.7	17.6	27.8	12.2	8.9	15.5	17.0	13.3	20.6	19.5	15.8	23.2
Income as ratio of federal poverty level																								
<1	27.7	21.1	34.4	21.8	15.7	27.8	23.4	16.2	30.5	15.4	9.1	21.6	16.5	11.8	21.2	11.9	8.2	15.7	14.8	10.6	19.0	14.1	9.5	18.6
1-2	23.0	17.5	28.5	25.8	20.5	31.0	18.4	13.7	23.0	14.9	9.6	20.3	17.8	13.1	22.4	11.4	8.2	14.6	12.9	9.3	16.4	13.1	9.4	16.8
>=2	25.6	22.6	28.6	28.0	24.6	31.4	19.7	16.2	23.3	20.7	16.9	24.4	22.3	19.0	25.6	12.5	10.1	14.8	15.6	13.4	17.7	19.0	16.3	21.6
Insured																								
Covered	28.8	10.1	22.2	31.4	29.0	33.9	23.1	20.3	26.0	20.7	17.6	23.7	23.4	20.7	26.1	13.4	11.6	15.2	15.9	14.0	17.8	17.8	15.7	20.0
Uncovered	16.1	26.6	31.1	14.3	8.8	19.8	16.1	9.1	23.1	10.6	5.2	16.1	7.9	4.2	11.5	5.2	2.5	7.9	5.4	1.9	8.9	10.6	3.8	17.3

Table 4. Characteristics of Women Who Have Any Receipt of A Mammogram and Those Women Who Have Received a Mammogram in the Past 12 Months.

	Ever Had a Mammogram			Had a Mammogram in the past 12 months		
	%	95% CI		%	95% CI	
Age						
30-34	15.3591	14.6898	16.0283	12.4591	9.1276	15.7907
35-39	28.7801	27.9378	29.6225	26.2882	21.6655	30.9109
40-44	55.8608	54.9729	56.7487	61.2527	56.2462	66.2592
Race						
Non-Hispanic White	78.6142	78.1267	79.1018	76.6988	74.7806	78.6169
Non-Hispanic Black	12.2767	11.8865	12.6670	13.1327	11.6337	14.6317
Hispanic	9.1090	8.7969	9.4212	10.1686	8.9075	11.4296
Geography						
Northeast	19.0383	18.5777	19.4989	20.2523	18.1879	22.3167
Midwest	23.8454	23.3389	24.3519	26.5277	24.3058	28.7495
South	36.9153	36.2879	37.5428	29.8219	27.3848	32.2590
West	20.2009	19.7097	20.6921	23.3981	21.3775	25.4188
Education						
No Highschool Diploma	12.1707	11.8570	12.4844	14.2112	12.8842	15.5382
Highschool Diploma	30.1443	29.7166	30.5720	32.1070	30.2203	33.9937
<4 years of College	29.7670	29.3852	30.1488	27.8972	26.0354	29.7591
4+ years of College	27.9180	27.4276	28.4085	25.7845	23.8421	27.7270
Income as ratio of federal poverty level						
<1	11.9656	11.6250	12.3063	12.8133	11.3740	14.2527
1-2	18.5760	18.1845	18.9675	19.1878	17.4140	20.9615
>=2	69.4583	68.9306	69.9861	67.9989	65.8807	70.1171
Insurance						
Covered	92.8614	92.6478	93.0749	95.0942	94.1953	95.9931
Uncovered	7.1386	6.9251	7.3522	4.9058	4.0069	5.8047

Table 5. Adjusted Predicted Prevalence Rate Ratio of 30-34 and 35-39-year-old Women of Ever Having A Mammogram When Compared with 40–44-year-old Women From 2000-2018

	2000			2003			2005			2008			2010			2013			2015			2018		
	%	95% CI		%	95% CI		%	95% CI		%	95% CI		%	95% CI		%	95% CI		%	95% CI		%	95% CI	
30-34	0.240	0.210	0.274	0.262	0.229	0.300	0.269	0.236	0.307	0.264	0.227	0.308	0.270	0.233	0.312	0.287	0.255	0.323	0.257	0.222	0.297	0.304	0.264	0.349
35-39	0.564	0.525	0.605	0.580	0.539	0.624	0.534	0.490	0.582	0.534	0.486	0.588	0.493	0.448	0.542	0.470	0.425	0.521	0.456	0.407	0.511	0.408	0.359	0.463

Table 6. Adjusted Predicted Prevalence Rate Ratio of 30-34 and 35–39-year-olds Having Had A Mammogram in the Past 12 Months Compared with 40–44-year-old Women From 2000-2018

	2000			2003			2005			2008			2010			2013			2015			2018		
	%	95% CI		%	95% CI		%	95% CI		%	95% CI		%	95% CI		%	95% CI		%	95% CI		%	95% CI	
30-34	0.728	0.364	1.455	0.3	0.091	0.986	1.059	0.350	3.202	0.988	0.347	2.817	0.482	0.212	1.099	1.124	0.348	3.633	0.394	0.109	1.430	0.178	0.047	0.674
35-39	0.605	0.358	1.021	0.693	0.361	1.329	0.193	0.04	0.936	0.661	0.207	2.104	0.510	0.235	1.105	1.856	0.745	4.622	0.821	0.343	1.965	0.786	0.325	1.897

Table7. Adjusted PRR of Ever Having A Mammogram For Black Women Aggregated By Pair of Years Compared to 2000-2003 Prevalence Rate.

	Among women 30-34y			Among women 35-39y			Among women 40-44y		
	%	95%CI		%	95%CI		%	95%CI	
2005-2008 vs. 2000-2003	1.265	0.972	1.646	1.088	0.921	1.285	1.023	0.930	1.124
2010-2013 vs. 2000-2003	1.530*	1.216	1.924	0.985	0.818	1.186	0.943	0.855	1.039
2015-2018 vs. 2000-2003	1.174	0.896	1.540	0.929	0.966	1.261	0.958	0.861	1.067

Table8. Adjusted PRR of Having A Mammogram in The Past 12 Months For Black Women Aggregated By Pair of Years Compared to 2003.

	Among women 30-34y			Among women 35-39y			Among women 40-44y		
	%	95%CI		%	95%CI		%	95%CI	
2005-2008 vs. 2000-2003	1.763	0.291	10.689	2.402	0.250	23.072	0.882	0.347	2.241
2010-2013 vs. 2000-2003	0.257	0.024	2.725	1.228	0.157	9.600	0.529	0.239	1.168
2015-2018 vs. 2000-2003	2.961	0.741	11.833	4.829	0.645	36.136	0.839	0.351	2.002

Table 9. PRR of ever having receipt of a mammogram for white women by pair of years compared to 2000-2003 prevalence rate for the same age and race adjusted for all other covariates.

	Among women 30-34y			Among women 35-39y			Among women 40-44y		
	PRR	95%CI		PRR	95%CI		PRR	95%CI	
2005-2008 vs. 2000-2003	1.017	0.850	1.217	0.925	0.840	1.018	1.005	0.962	1.050
2010-2013 vs. 2000-2003	0.983	0.820	1.180	0.784*	0.709	0.868	0.958	0.914	1.003
2015-2018 vs. 2000-2003	0.903	0.752	1.085	0.619*	0.548	0.698	0.879*	0.835	0.925

Table 10. PRR of having had a mammogram in the past 12 months for white women by pair of years compared to 2000-2003 prevalence rate for the same age and race adjusted for all other covariates.

	Among women 30-34y			Among women 35-39y			Among women 40-44y		
	PRR	95%CI		PRR	95%CI		PRR	95%CI	
2005-2008 vs. 2000-2003	1.403	0.459	4.289	0.283	0.055	1.463	0.518*	0.271	0.989
2010-2013 vs. 2000-2003	0.597	0.156	2.288	0.762	0.383	1.518	0.629	0.378	1.047
2015-2018 vs. 2000-2003	0.723	0.231	2.264	0.730	0.323	1.654	0.822	0.518	1.305

Table 11. PRR of ever having receipt of mammogram for Hispanic women by pair of years compared to 2000-2003 prevalence rate for the same age and race after adjustment for other covariates.

	Among women 30-34y			Among women 35-39y			Among women 40-44y		
	PRR	(95%CI)		PRR	(95%CI)		PRR	(95%CI)	
2005-2008 vs. 2000-2003	1.009	0.784	1.298	0.866	0.718	1.046	0.995	0.9	1.101
2010-2013 vs. 2000-2003	0.862	0.689	1.077	0.809*	0.681	0.960	1.070	0.987	1.159
2015-2018 vs. 2000-2003	1.035	0.814	1.317	0.701*	0.573	0.857	0.989	0.900	1.088

Table 12. PRR of ever having receipt of mammogram for Hispanic women by pair of years compared to 2000-2003 prevalence rate for the same age and race after adjustment for other covariates.

	Among women 30-34y			Among women 35-39y			Among women 40-44y		
	PRR	(95%CI)		PRR	(95%CI)		PRR	(95%CI)	
2005-2008 vs. 2000-2003	0.491	0.081	2.963	1.207	0.191	7.641	1.166	0.578	2.353
2010-2013 vs. 2000-2003	1.082	0.302	3.882	1.162	0.327	4.136	0.293*	0.099	0.872
2015-2018 vs. 2000-2003	2.794	0.954	8.181	0.384	0.045	3.313	0.478	0.198	1.152

Figure 1. Adjusted Prevalence Rate Ratio of 30-34 and 35-39-year-old Women of Ever Having A Mammogram When Compared with 40–44-year-old Women From 2000-2018

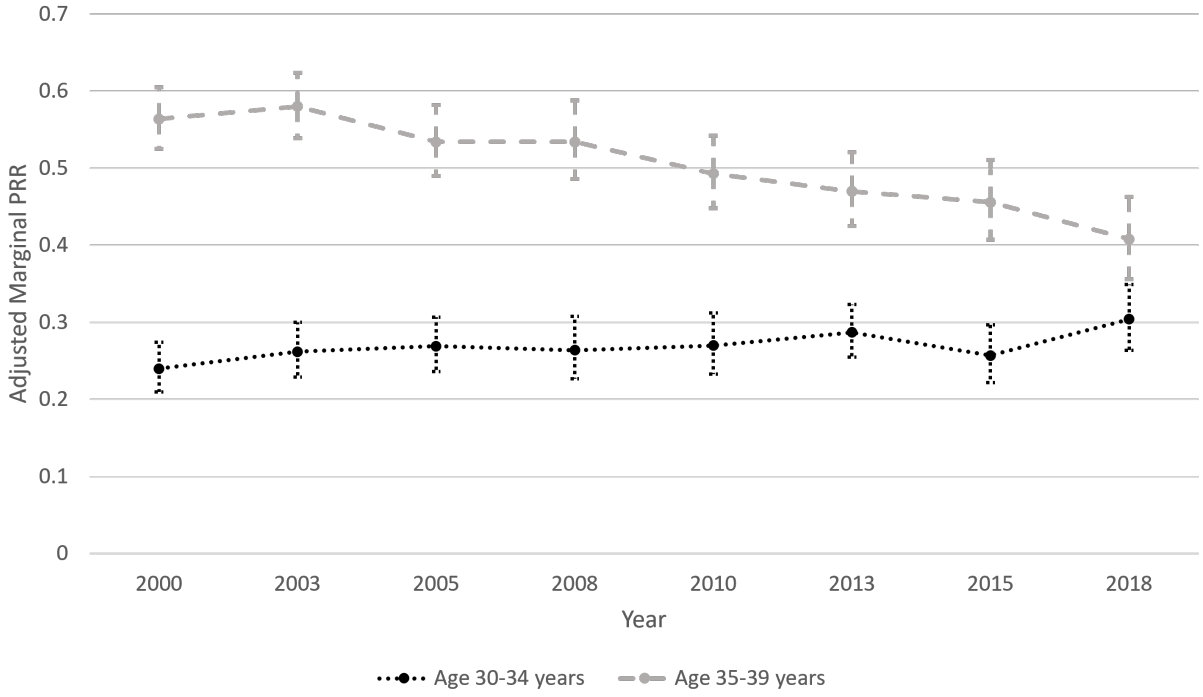
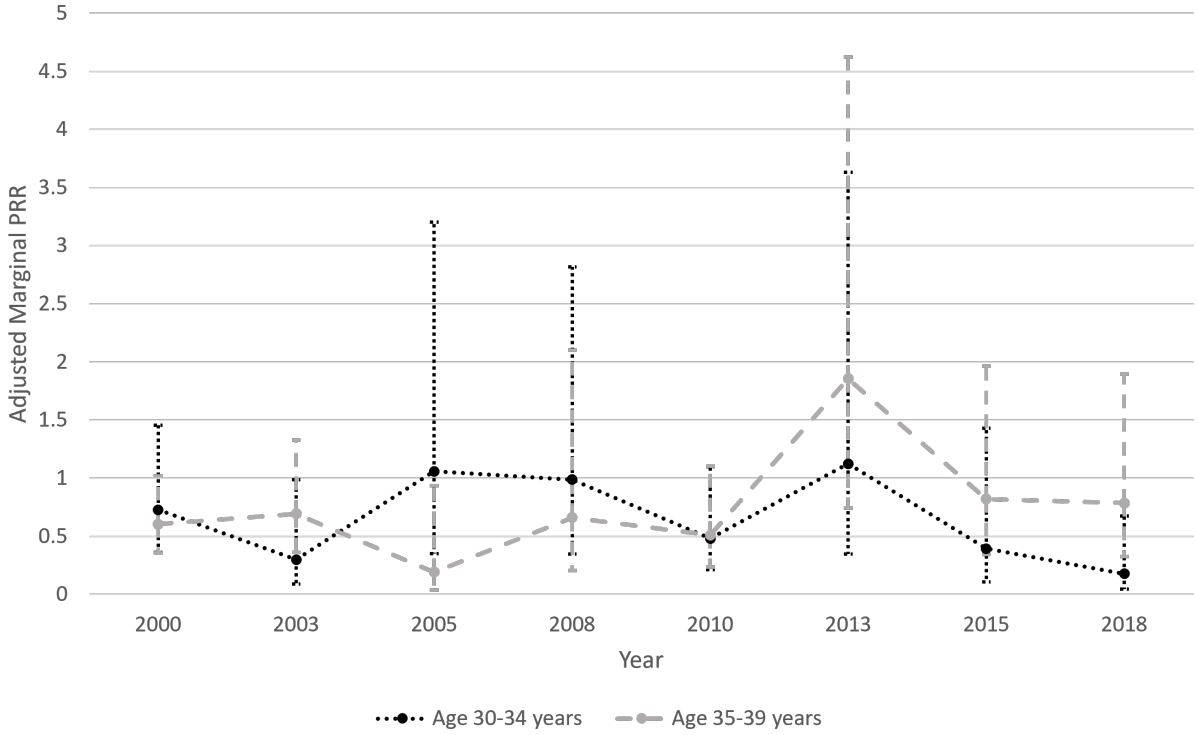


Figure 2. Adjusted Prevalence Rate Ratio of 30-34 and 35–39-year-olds Having Had A Mammogram in the Past 12 Months Compared with 40-44-year-old Women From 2000-2018



Citations

1. Surveillance, Epidemiology, And End Results (SEER) Program.Seer.cancer.gov
2. Richardson LC, Henley SJ, Miller JW, Massetti G, Thomas CC. Patterns and Trends in Age-Specific Black-White Differences in Breast Cancer Incidence and Mortality - United States, 1999-2014. MMWR Morb Mortal Wkly Rep. 2016 Oct 14;65(40):1093-1098. doi: 10.15585/mmwr.mm6540a1. PMID: 27736827.
3. Reynolds H. The Big Squeeze: a Social and Political History of the Controversial Mammogram. New York: Cornell University Press; 2012
4. Schattner E. Correcting a decade of negative news about mammography. Clin Imaging. 2020 Apr;60(2):265-270. doi: 10.1016/j.clinimag.2019.03.011. Epub 2019 Apr 4. PMID: 30982701.
5. Lauby-Secretan B, Scoccianti C, Loomis D, et al. on behalf of the International Agency for Research on Cancer Handbook Working Group Breast-cancer screening—viewpoint of the iarc Working Group. N Engl J Med. 2015;372:2353–8. doi: 10.1056/NEJMsr1504363.
6. Humphrey LL, Helfand M, Chan BK, Woolf SH. Breast cancer screening: a summary of the evidence for the U.S. Preventive Services Task Force. Ann Intern Med. 2002 Sep 3;137(5 Part 1):347-60. doi: 10.7326/0003-4819-137-5_part_1-200209030-00012. PMID: 12204020.
7. *Nelson HD, Tyne K, Naik A, et al.* Screening for breast cancer: an update for the U.S. Preventive Services Task Force*. Ann Intern Med. 2009;151(10):727-737.*
8. Institute of Medicine (US) and National Research Council (US) Committee on New Approaches to Early Detection and Diagnosis of Breast Cancer. Saving Women's Lives: Strategies for Improving Breast Cancer Detection and Diagnosis. Joy JE, Penhoet EE,

Petitti DB, editors. Washington (DC): National Academies Press (US); 2005. PMID: 20669447.

9. Berry DA, Cronin KA, Plevritis SK, Fryback DG, Clarke L, Zelen M, Mandelblatt JS, Yakovlev AY, Habbema JD, Feuer EJ; Cancer Intervention and Surveillance Modeling Network (CISNET) Collaborators. Effect of screening and adjuvant therapy on mortality from breast cancer. N Engl J Med. 2005 Oct 27;353(17):1784-92. doi: 10.1056/NEJMoa050518. PMID: 16251534.
10. Nelson HD, Fu R, Cantor A, Pappas M, Daeges M, Humphrey L. Effectiveness of Breast Cancer Screening: Systematic Review and Meta-analysis to Update the 2009 U.S. Preventive Services Task Force Recommendation. Ann Intern Med. 2016 Feb 16;164(4):244-55. doi: 10.7326/M15-0969. Epub 2016 Jan 12. PMID: 26756588.
11. Smith RA, Saslow D, Sawyer KA, Burke W, Costanza ME, Evans WP 3rd, Foster RS Jr, Hendrick E, Eyre HJ, Sener S; American Cancer Society High-Risk Work Group; American Cancer Society Screening Older Women Work Group; American Cancer Society Mammography Work Group; American Cancer Society Physical Examination Work Group; American Cancer Society New Technologies Work Group; American Cancer Society Breast Cancer Advisory Group. American Cancer Society guidelines for breast cancer screening: update 2003. CA Cancer J Clin. 2003 May-Jun;53(3):141-69. doi: 10.3322/canjclin.53.3.141. PMID: 12809408.
12. U.S. Preventive Services Task Force. Screening for breast cancer: recommendations and rationale. Ann Intern Med. 2002 Sep 3;137(5 Part 1):344-6. doi: 10.7326/0003-4819-137-5_part_1-200209030-00011. PMID: 12204019.

13. Goodson WH 3rd, Miller TR, Sickles EA, Upton RA. Lack of correlation of clinical breast examination with high-risk histopathology. Am J Med. 1990 Dec;89(6):752-6. doi: 10.1016/0002-9343(90)90217-2. PMID: 2174645.

14. Myers ER, Moorman P, Gierisch JM, Havrilesky LJ, Grimm LJ, Ghate S, Davidson B, Mongtomery RC, Crowley MJ, McCrory DC, Kendrick A, Sanders GD. Benefits and Harms of Breast Cancer Screening: A Systematic Review. JAMA. 2015 Oct 20;314(15):1615-34. doi: 10.1001/jama.2015.13183. Erratum in: JAMA. 2016 Apr 5;315(13):1406. PMID: 26501537.

15. Oeffinger KC, Fontham ET, Etzioni R, Herzig A, Michaelson JS, Shih YC, Walter LC, Church TR, Flowers CR, LaMonte SJ, Wolf AM, DeSantis C, Lortet-Tieulent J, Andrews K, Manassaram-Baptiste D, Saslow D, Smith RA, Brawley OW, Wender R; American Cancer Society. Breast Cancer Screening for Women at Average Risk: 2015 Guideline Update From the American Cancer Society. JAMA. 2015 Oct 20;314(15):1599-614. doi: 10.1001/jama.2015.12783. Erratum in: JAMA. 2016 Apr 5;315(13):1406. PMID: 26501536; PMCID: PMC4831582.

16. Siu AL; U.S. Preventive Services Task Force. Screening for Breast Cancer: U.S. Preventive Services Task Force Recommendation Statement. Ann Intern Med. 2016 Feb 16;164(4):279-96. doi: 10.7326/M15-2886. Epub 2016 Jan 12. Erratum in: Ann Intern Med. 2016 Mar 15;164(6):448. PMID: 26757170.

17. Radhakrishnan A, Nowak SA, Parker AM, Visvanathan K, Pollack CE. Physician Breast Cancer Screening Recommendations Following Guideline Changes: Results of a National Survey. JAMA Intern Med. 2017 Jun 1;177(6):877-878. doi: 10.1001/jamainternmed.2017.0453. PMID: 28395005; PMCID: PMC5561425.

18. Fowble BL, Schultz DJ, Overmoyer B, Solin LJ, Fox K, Jardines L, Orel S, Glick JH. The influence of young age on outcome in early stage breast cancer. Int J Radiat Oncol Biol Phys. 1994 Aug 30;30(1):23-33. doi: 10.1016/0360-3016(94)90515-0. PMID: 8083119.

19. Wray CJ, Phatak UR, Robinson EK, Wiatek RL, Rieber AG, Gonzalez A, Ko TC, Kao LS. The effect of age on race-related breast cancer survival disparities. Ann Surg Oncol. 2013 Aug;20(8):2541-7. doi: 10.1245/s10434-013-2913-x. Epub 2013 Feb 24. PMID: 23435633.

20. Liu Z, Sahli Z, Wang Y, Wolff AC, Cope LM, Umbricht CB. Young age at diagnosis is associated with worse prognosis in the Luminal A breast cancer subtype: a retrospective institutional cohort study. Breast Cancer Res Treat. 2018 Dec;172(3):689-702. doi: 10.1007/s10549-018-4950-4. Epub 2018 Sep 17. PMID: 30225619; PMCID: PMC6786966.

21. *Mainiero MB, Lourenco A, Mahoney MC, et al.* ACR appropriateness criteria breast cancer screening. *J Am Coll Radiol. 2016;13(11S):R45-R49*

22. *Daly MB, Pilarski R, Berry M, et al.* NCCN guidelines insights: genetic/familial high-risk assessment: breast and ovarian, Version 2.2017. *J Natl Compr Canc Netw. 2017;15(1):9-20*

23. *Saslow D, Boetes C, Burke W, et al.* American cancer society guidelines for breast screening with MRI as an adjunct to mammography. *CA Cancer J Clin. 2007;57(2):75-89*

24. Keramatinia A, Mousavi-Jarrahi SH, Hiteh M, Mosavi-Jarrahi A. Trends in incidence of breast cancer among women under 40 in Asia. Asian Pac J Cancer Prev 2014;15(3):1387–90.

25. Merlo DF, Ceppi M, Filiberti R, et al. Breast cancer incidence trends in European women aged 20-39 years at diagnosis. Breast Cancer Res Treat 2012;134(1): 363–70.

26. Lima SM, Kehm RD, Swett K, Gonsalves L, Terry MB. Trends in Parity and Breast Cancer Incidence in US Women Younger Than 40 Years From 1935 to 2015. JAMA Netw Open. 2020 Mar 2;3(3):e200929. doi: 10.1001/jamanetworkopen.2020.0929. PMID: 32167569; PMCID: PMC7070232.

27. Thomas A, Rhoads A, Pinkerton E, Schroeder MC, Conway KM, Hundley WG, McNally LR, Oleson J, Lynch CF, Romitti PA. Incidence and Survival Among Young Women With Stage I-III Breast Cancer: SEER 2000-2015. JNCI Cancer Spectr. 2019 Jun 7;3(3):pkz040. doi: 10.1093/jncics/pkz040. PMID: 31392297; PMCID: PMC6668585.

28. Hendrick RE, Helvie MA, Monticciolo DL. Breast Cancer Mortality Rates Have Stopped Declining in U.S. Women Younger than 40 Years. Radiology. 2021 Apr;299(1):143-149. doi: 10.1148/radiol.2021203476. Epub 2021 Feb 9. PMID: 33560186.

29. Pollán M. Epidemiology of breast cancer in young women. Breast Cancer Res Treat. 2010 Sep;123 Suppl 1:3-6. doi: 10.1007/s10549-010-1098-2. Epub 2010 Aug 14. PMID: 20711654.

30. Hubbard RA, Kerlikowske K, Flowers CI, Yankaskas BC, Zhu W, Miglioretti DL. Cumulative probability of false-positive recall or biopsy recommendation after 10 years of screening mammography: a cohort study. Ann Intern Med. 2011;155:481–92. doi: 10.7326/0003-4819-155-8-201110180-00004.

31. Lynn A. Blewett, Julia A. Rivera Drew, Miriam L. King and Kari C.W. Williams. IPUMS Health Surveys: National Health Interview Survey, Version 6.4 [dataset]. Minneapolis, MN: IPUMS, 2019. https://doi.org/10.18128/D070.V6.4

32. Ghafoor A, Jemal A, Ward E, Cokkinides V, Smith R, Thun M. Trends in breast cancer by race and ethnicity. CA Cancer J Clin. 2003 Nov-Dec;53(6):342-55. doi:

10.3322/canjclin.53.6.342. Erratum in: CA Cancer J Clin. 2004 May-Jun;54(3):181. PMID: 15224974.

33. Iqbal J, Ginsburg O, Rochon PA, Sun P, Narod SA. Differences in breast cancer stage at diagnosis and cancer-specific survival by race and ethnicity in the United States. JAMA. 2015 Jan 13;313(2):165-73. doi: 10.1001/jama.2014.17322. Erratum in: JAMA. 2015 Jun 9;313(22):2287. PMID: 25585328.
34. Du X. Racial disparities in health insurance, triple-negative breast cancer diagnosis, tumor stage, treatment and survival in a large nationwide SEER cohort in the United States. Mol Clin Oncol. 2022 Apr;16(4):95. doi: 10.3892/mco.2022.2528. Epub 2022 Mar 2. PMID: 35368847; PMCID: PMC8943535.
35. Rauscher GH, Johnson TP, Cho YI, Walk JA. Accuracy of self-reported cancer-screening histories: a meta-analysis. Cancer Epidemiol Biomarkers Prev. 2008 Apr;17(4):748-57. doi: 10.1158/1055-9965.EPI-07-2629. Epub 2008 Apr 1. PMID: 18381468.