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Tumor Characteristics Associated with Tomosynthesis versus Digital Mammography for Breast Cancer Screening in Older Women

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Abstract

Purpose: Digital breast tomosynthesis (DBT) has demonstrated improved cancer detection compared with digital mammography (DM) in women aged 50-74, identifying more invasive cancers and detecting tumors at smaller sizes. However, its benefits for women aged 75 and older remain unclear.

Methods: We conducted a SEER-Medicare retrospective cohort study of women aged ≥67 diagnosed with screen-detected ER+/HER2- breast cancer from 2015-2021. The primary exposure was screening modality (DBT vs. DM). Outcomes included tumor size, nodal involvement, grade, and histology (invasive lobular carcinoma [ILC] vs. non-ILC). Multivariable logistic regression was used to assess the association between screening modality and tumor characteristics among women aged 67-74 and ≥75.

Results: Among 17,201 women with screen-detected breast cancer, 43.6% were ≥75 at diagnosis and 60.4% were detected by DBT. In women aged 67-74, DBT was associated with higher odds of smaller tumors (adjusted odds ratio [aOR]=1.18, 95% confidence interval [CI]=1.08-1.29), grade I vs. II or III disease (aOR=1.14, CI=1.04-1.26), node-negative disease (aOR=1.15, CI=1.00-1.31), and ILC histology (aOR=1.29, CI=1.13-1.48) vs. DM. In contrast, among women aged ≥75, DBT remained associated with higher odds of grade I tumors (aOR=1.21, CI=1.08-1.35) and node-negative disease (aOR=1.18, CI=1.00-1.39), but was not significantly associated with smaller tumor size (aOR=0.99, CI=0.90-1.10) or ILC histology (aOR=1.13, CI=0.98-1.32).

Conclusions: DBT was associated with favorable tumor biology, including lower grade and node-negative disease in women ≥75, but not with smaller tumor size or ILC histology. The incremental advantage of DBT over DM may diminish with age, making the two modalities more comparable in women ≥75.

Introduction

Breast cancer screening is critical for the early detection of breast cancer, which can reduce mortality by identifying cancers at earlier, more treatable stages. Currently, biennial screening mammography is recommended for women aged 40–74 by the U.S. Preventive Services Task Force.[1, 2] Digital breast tomosynthesis (DBT), introduced in 2011, has become increasingly adopted as a tool for breast cancer screening.[3] Compared to digital mammography (DM), DBT has been associated with increased invasive cancer detection and detection of smaller tumors in some randomized trials and observational studies, although findings have been inconsistent across populations and study designs.[4–8]

Despite this evidence, the effectiveness of DBT in women 75 and older remains understudied, as they are often excluded from clinical trials due to their age.[2] In this population, the benefit of DBT may be reduced by lower breast density, a greater proportion of indolent tumors, and higher competing mortality.[9–12] Nonetheless, some benefits of screening may still extend to this population: in our prior study of women diagnosed with breast cancer by screening, women 75 and older with at least one screening before diagnosis had better breast cancer-specific survival than those without.[13]

In this retrospective cohort study, we aimed to evaluate whether screening modality at breast cancer detection (DBT vs. DM) is associated with more favorable tumor characteristics in women older than 75. We hypothesized that DBT is more likely to detect tumors at an earlier stage, including smaller tumor size and absence of nodal involvement, and improves detection of mammographically occult cancers, including lower-grade tumors and invasive lobular carcinoma (ILC) histology.

Methods

Data Source

Data were obtained from the Surveillance, Epidemiology, and End Results (SEER)-Medicare data.[14] These linked data provide patient demographics, cancer diagnoses, tumor biology, and treatment received. Data covered January 1, 2013, to December 31, 2021.

This cohort study was determined to be exempt from review and informed consent by the Yale School of Medicine institutional review board because SEER-Medicare data were deidentified and informed consent was not required. We followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE reporting guideline.

Cohort selection

The cohort included women diagnosed with ER+/HER2- breast cancer at age 67 or older from 2015 through 2021. All women were diagnosed at a routine screening mammogram. Breast cancers detected at screening were distinguished from those that were symptomatic using a validated claims-based algorithm developed by Fenton et al.[15, 16] The algorithm uses time since the last mammogram, the presence of diagnostic Healthcare Common Procedure Coding System (HCPCS) codes, and presence of ICD-9/10 diagnostic codes for breast symptoms to distinguish diagnostic from screening mammograms (eMethods 1).[17] Women were required to maintain continuous enrollment in Medicare Part A and B fee-for-service coverage from two years prior to diagnosis through one year after. Women with missing information on disease characteristics or sociodemographic factors were excluded. (Fig. 1).

Exposure

The primary exposure was screening modality at breast cancer detection, classified as DBT or DM, identified using the billing codes present on the claim (eTable 1).

Outcomes

The primary outcomes included tumor size, nodal involvement, grade, and histology at diagnosis. Tumor size was categorized in 10-mm intervals to reflect clinically meaningful survival differences.[18, 19] Tumors ≥51mm were collapsed into one category, as prognostic differences above this size are minimal.

Nodal involvement was classified as N0 versus N1+ to distinguish local from regional disease. Tumor grade was dichotomized into grade I versus grade II or III to reflect distinctions between well-differentiated (low-grade) and moderately to poorly differentiated (high-grade) tumors. Histology was categorized as ILC versus other histology, including invasive ductal carcinoma (IDC) and mixed ductal and lobular carcinoma. This classification was chosen because ILC histology can be difficult to detect with DM due to its diffuse growth pattern and lack of calcifications.[20-23]

Covariates

All demographic, socioeconomic, tumor, and treatment-related factors were collected at diagnosis. Demographic factors included age, race and ethnicity, and marital status. Race and ethnicity were obtained from Medicare data, which is based on self-report.[24]

Indicators of social and economic vulnerability were measured at the individual and area level. Medicare and Medicaid dual eligibility for at least one month in the year before cancer diagnosis was included as an individual-level socioeconomic indicator. Area-level socioeconomic variables were measured at the census tract or zip-code level. Area-level variables included percentage of residents of Black race, percentage of residents residing in an urban area, and median household income. Year of diagnosis was included to control for temporal trends in the adoption of DBT and tumor characteristics.

Clinical factors included frailty and number of comorbidities. Frailty was measured using claims during the year preceding diagnosis using the Kim claims-based frailty index.[25] The number of comorbidities present at diagnosis was measured in the 2 years preceding diagnosis using the Elixhauser comorbidity index.[26]

Indicators of healthcare utilization included a previous screening mammogram, any visit with a primary care physician (PCP), receipt of a flu shot, and an Annual Wellness Visit (AWV) in the two years before breast cancer diagnosis (eTable 1).[13, 27, 28]

Statistical Analysis

The study aimed to assess the extent to which DBT was associated with favorable disease characteristics in women aged 75 and older, a group not universally recommended for screening and excluded from pivotal DBT trials.[2, 6, 7] To allow for age-specific comparisons, all analyses were conducted separately for women aged ≥75 and those aged 67-74. Bivariate logistic regression was used to identify factors associated with screening modality at detection and tumor characteristics. Multivariable logistic regression, adjusted for confounders identified in bivariate analyses, was used to assess an association between screening modality and tumor characteristics. Ordinal logistic regression was used for the tumor size outcome; we used the largest tumor size category (≥51mm) as the reference group, such that higher odds ratios indicated greater detection of smaller tumors.

All multivariable models were adjusted for sociodemographic characteristics, health care engagement, clinical characteristics, and year of diagnosis. Additionally, each model was adjusted for tumor

characteristics (tumor size, grade, histology, and nodal status), excluding the characteristic that was the outcome in that model (e.g., models with tumor size as the outcome were adjusted for grade, histology, and nodal status but not tumor size).

Because screening modality is not randomly assigned, we additionally prespecified an analysis to characterize factors associated with receipt of DBT and to assess whether selection into screening modality differed by age group, in order to inform interpretation of the primary associations between screening modality and tumor characteristics

The level of significance was set at $P<0.05$ and hypothesis tests were two-sided. Collinearity was assessed using a variance inflation factor (VIF)>10; no covariates ended up being excluded for collinearity. The proportional odds assumption of the ordinal logistic regression was tested using the Brant test, which assesses whether the effect of the independent variables is consistent across all pairs of tumor size categories.

Sensitivity Analyses

We conducted a sensitivity analysis to examine whether age-specific differences were driven by model overadjustment rather than true differences in the associations between screening modality and tumor characteristics. Because tumor size, grade, histology, and nodal status are related features, adjusting for the other three tumor characteristics in each main model may introduce overadjustment or collider bias. To address this, the sensitivity models retained the same sociodemographic, clinical, and health care engagement covariates but omitted all tumor-related covariates, which allows us to estimate the total association between screening modality and each tumor characteristic.

Data were analyzed from March 1, 2024, to September 18, 2024. All analyses were conducted using SAS® version 9.4 (SAS Institute Inc., Cary, NC, USA) and Rstudio version 2023.06.1.

Results

Cohort Description & Trend in Use of Digital Breast Tomosynthesis

A total of 17,201 women aged 67 years and older with screen-detected breast cancer were included (Figure 1). Of these, 9,697 (56.4%) were aged 67-74 years and 7,504 (43.6%) were aged 75 years or older at diagnosis (Table 1). More than half of breast cancers were detected with DBT, including 6,024 (62.1%) among women aged 67-74 and 4,363 (58.1%) among those aged 75 and older (Table 1). In both age groups, the proportion of breast cancers diagnosed with DBT increased between 2015 and 2021, rising from 26.5% to 87.4% in women aged 67-74 and from 22.7% to 87.3% in women 75 and older.

Tumor characteristics were similar across age groups: a larger proportion of women had ILC compared with IDC or mixed histology (15.0% in 67-74 vs. 16.0% in ≥75), tumors ≤20 mm (80.4% vs. 78.2%), Grade II or higher tumors (64.4% vs. 64.4%), and no nodal involvement (84.6% vs. 86.3%).

Association Between Screening Modalities and Tumor Characteristics

Tumor Size

Among women aged 67-74, DBT-detected tumors were more likely ≤20 mm (81.6% vs 78.3%; p<0.05). After adjusting for tumor grade, nodal involvement, histology, sociodemographic characteristics, health care engagement, clinical status, and year of diagnosis, DBT was associated with 18% higher odds of detecting smaller tumors (aOR=1.18, 95% CI=1.08-1.29).

Among women aged ≥75, 79.9% of DBT-detected tumors were ≤20 mm compared with 75.8% detected with DM (p<0.05). In the adjusted model, there was no significant association between DBT and tumor size (aOR=0.99, CI=0.90-1.10) (Figure 2A).

Nodal involvement

Among women aged 67-74, 85.8% of DBT-detected tumors were node-negative compared with 82.5% detected with DM (p<0.05). After adjustment, DBT was associated with 15% higher odds of node-negative disease (aOR=1.15, CI=1.00-1.31).

Among women aged ≥75, 87.9% of DBT-detected tumors were node-negative compared with 84.2% with DM (p<0.05). In adjusted analyses, DBT was associated with 18% higher odds of node-negative disease (aOR=1.18, CI=1.00-1.39) (Figure 2B).

Tumor grade

Among women aged 67-74, 36.4% of DBT-detected tumors were Grade I versus 34.4% detected with DM (p<0.05). Adjusted analyses showed DBT was associated with 14% higher odds of detecting Grade I tumors (aOR=1.14, CI=1.04-1.26).

Among women aged ≥75, 37.3% of DBT-detected tumors were Grade I versus 33.2% detected with DM (p<0.05). After adjustment, DBT was associated with 21% higher odds of Grade I tumors (aOR=1.21, CI=1.08-1.35) (Figure 2C).

Histology

Among women aged 67-74, 15.9% of DBT-detected tumors were ILC compared with 13.5% detected with DM (p<0.05). In the adjusted model, DBT was associated with 28% higher odds of ILC histology (aOR=1.29, CI=1.13-1.48).

Among women aged ≥75, 16.7% of DBT-detected tumors were ILC compared with 15.0% detected with DM (p<0.05). After adjustment, the association was not statistically significant (aOR=1.13, CI=0.98-1.32) (Figure 2D).

Receipt of DBT vs DM

To understand whether selection into screening modalities varied by age, we compared associations between patient and system-level factors and the likelihood of receiving DBT within each age group (Figure 3).

Indicators of social disadvantage showed slightly stronger inverse associations with DBT use among women ≥75 than among those 67-74. Among women 67-74, dual eligibility for Medicare and Medicaid was associated with 46% lower odds of DBT use (aOR=0.54, 95% CI=0.46-0.64), compared with 58% lower odds in women ≥75 (aOR=0.42, CI=0.35-0.52). Residence in the highest-income area (≥$110k/year) was associated with higher DBT use in both groups, with a slightly stronger association among women ≥75 (aOR=1.24, CI=1.02-1.50) than in those 67-74 (aOR=1.14, CI=0.96-1.36). However, urban residence was more strongly associated with DBT use in women 67-74 (aOR=1.34, CI=1.17-1.54) compared with women ≥75 (aOR=1.21, CI=1.03-1.43).

Health care engagement prior to diagnosis was associated with DBT use in both age groups, with generally stronger associations among women aged ≥75. Among women aged 67–74, both a primary care visit (aOR=1.07, 95% CI=0.93–1.23) and receipt of an influenza vaccination (aOR=1.08, 95% CI=0.98–1.19) were modestly associated with higher DBT use. In contrast, among women aged ≥75, these associations were larger for both a primary care visit (aOR=1.27, 95% CI=1.06–1.52) and influenza vaccination (aOR=1.27, 95% CI=1.13–1.43).

Sensitivity Analyses

Models Without Adjustment for Other Tumor Characteristics

In the sensitivity analysis removing adjustment for the other tumor characteristics, associations between DBT and tumor features were consistent in direction with the main findings but modestly stronger in magnitude (eFigure 1). For tumor size, estimates increased slightly from 1.18 to 1.22 (95% CI=1.12-1.33) in women aged 67-74 and from essentially null to 1.08 (CI=0.98-1.19) in women aged ≥75. For nodal status, estimates rose from 1.15 to 1.21 (CI=1.06-1.37) in the 67-74 cohort and from 1.18 to 1.26 (CI=1.08-1.47) in the ≥75 cohort. For tumor grade, the increases were modest (aOR in 67-74: 1.14 to 1.18; ≥75: 1.21 to 1.23). Estimates for lobular histology showed minimal change, with slight attenuation in women aged 67-74 and no association in women aged ≥75.

Discussion

In this study of older women with screen-detected breast cancer, we examined whether DBT was associated with more favorable tumor characteristics compared to DM and whether this differed by age at cancer detection. Findings for tumor grade and nodal status were generally consistent across women aged 67-74 and ≥75 years. In both cohorts, DBT was significantly associated with increased odds of detecting low-grade tumors (14% for ages 67-74; 21% for ages ≥75) and node-negative disease (15% and 18%, respectively). However, in the adjusted models, DBT was significantly associated with smaller tumors (18% higher odds) and ILC histology (28% higher odds) only in women aged 67-74, with no significant association in those aged ≥75. These results suggest that for women aged ≥75, DBT may improve

detection of biologically favorable tumors, but its benefit in detecting invasive breast cancer at a smaller tumor size may be limited above the routine use of DM.

Our finding of higher detection of node-negative disease with DBT compared to DM among women aged ≥75 aligns with prior research showing that DBT identified more stage I breast cancers in this age group. However, unlike our study, prior work reported a marginally higher rate of invasive tumors < 2 cm among women aged ≥75 screened with DBT compared to DM, while finding no significant difference in biologically favorable disease, defined by lower grade and positive hormone receptor status.[29] This discrepancy in findings regarding tumor size and grade may be driven by differences in study period and sample composition. Specifically, the prior study used SEER-Medicare data limited to 2015 while our study spanned from 2015 to 2021, a period during which DBT use expanded rapidly. Consequently, our analysis likely captured a more diverse population regarding access, health status, and provider practices.

To contextualize these findings, we examined differential DBT uptake between age groups. In general, indicators of socioeconomic disadvantage and lower healthcare engagement were associated with lower odds of DBT receipt, and these inverse associations were slightly stronger in women aged ≥75 than in those aged 67-74. This indicates that access to DBT may be more limited to those who are healthier and more engaged with care in women aged ≥75, and adjustment of these factors may have attenuated the association.

Sensitivity analyses confirmed that age-specific differences were not driven by model overadjustment. When removing adjustment for other tumor characteristics, associations between DBT and each tumor feature became uniformly stronger. This pattern is expected because the tumor features we studied are positively correlated with one another and adjusting for one favorable feature attenuates the benefit of DBT on the others. Importantly, the pattern of findings across age groups remained unchanged: the associations were generally stronger for DBT in women aged 67-74 compared with those aged ≥75, and DBT's associations with tumor size and histologic subtype continued to be insignificant in women aged ≥75.

Our study also found increased ILC detection with DBT in women aged 67-74. ILCs are often more difficult to detect with traditional DM due to their diffuse growth patterns and absence of calcifications, which may be more readily visualized with DBT.[20, 30, 31] A prior study from the Breast Cancer Surveillance Consortium reported a 50% higher relative risk of detecting ILC histology with DBT.[20] Our findings confirm this association in an older population using SEER-Medicare data. It underscores DBT's potential to improve detection of challenging tumor subtypes like ILC in older women.

While DBT may improve the detection of certain tumor subtypes, the null finding on tumor size raises concerns about overdiagnosis in women aged 75 and older. In this age group, DBT's association with lower-grade and node negative tumors but not increased detection of smaller tumors suggests that DBT may identify more indolent cancers. This can lead to overtreatment, including surgery, radiotherapy, or systemic therapy for cancers that may not impact a woman's life expectancy.[32, 33] This poses additional risks for older women, and they should be carefully weighed against potential benefits.

Limitations

Our study has some limitations. First, we only included women with screen-detected breast cancer rather than all women receiving mammograms, which means we compare the relative distribution of tumor characteristics conditional on a cancer diagnosis. Therefore, we are unable to assess the absolute detection rates or stage distribution across all mammograms. However, our findings remain informative on whether DBT facilitates a shift in the tumor characteristics compared to DM. This approach still allows us to evaluate whether DBT is more likely to detect cancers at an earlier point in their progression and to identify biologically favorable tumors that are typically harder to detect. Second, we were unable to fully account for the effect that factors such as breast density may have on the effectiveness of DBT, as this data is not available in the SEER-Medicare dataset.[14] However, we controlled for demographic, biological, and social factors that may confound the association between screening history and stage and mortality. Lastly, as a retrospective cohort study, our analysis is subject to residual confounding due to unmeasured differences between women receiving DBT and those receiving DM. Women undergoing DBT may have been at lower risk of advanced breast cancer, which could have influenced our findings. Lastly, DM versus DBT as the primary screening modality may have been influenced by provider choice based on factors not measurable in claims.

Conclusions

Our findings suggest that DBT may offer potential benefits as a routine screening tool for detecting lower-grade and node negative tumors in women aged 75 and older. However, its effectiveness for identifying earlier-stage disease may be more limited in this age group compared with younger women. These results underscore the need for further research to evaluate whether the detection of more favorable tumor subtypes translates into meaningful clinical outcomes in this age group.

Declarations

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Competing Interests: Dr Lustberg reported receiving personal fees from Novartis, Gilead, AstraZeneca, Daiichi-Sanko, Menarini, and Lilly and grants from Pfizer outside the submitted work. Dr Lewin reported receiving personal fees from Novian Health outside the submitted work. Dr Dinan reported receiving grants from the National Cancer Institute (NCI) and American Cancer Society (ACS). No other disclosures were reported.

Ethical Approval: This cohort study was determined to be exempt from review and informed consent by the Yale School of Medicine institutional review board because SEER-Medicare data were deidentified and informed consent was not required. We followed the STROBE reporting guideline.

Consent to Participate: Informed consent was waived by the Yale School of Medicine institutional review board due to the use of deidentified data.

Consent to Publish: Not applicable.

Data Sharing Statement: Data analyzed during the study were provided by a third party. Requests for data should be directed to the provider indicated in the Acknowledgements.

Data analyzed in this study were obtained from the SEER–Medicare linked database (National Cancer Institute and Centers for Medicare & Medicaid Services) and are proprietary under the SEER–Medicare Data Use Agreement; individual deidentified participant data, derived analytic datasets, and data dictionaries cannot be publicly shared by the authors. No additional related documents beyond those included in the manuscript and online supplementary materials will be made available. Access to the underlying data is available on an ongoing basis to qualified investigators through application to the SEER–Medicare program, subject to review, data use agreements, and associated fees; approved users may access the data only for the purposes and time period specified in their agreement, and reuse is restricted by the provider's policies and data use terms.

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Table 1

Table 1. Baseline characteristics of the 67-74 and 75+ cohorts and percent of each cohort with digital breast tomosynthesis (DBT)

	Women Aged 67-74			Women Aged ≥75		
	Overall Cohort	With DBT at Detection	P-value*	Overall Cohort	With DBT at Detection	P-value*
	N=9,697 (56.4%)	N=6,024 (62.1%)		N=7,504 (43.6%)	N=4,363 (58.1%)	
Tumor Size (mm)						
0 to 10	3885 (40.1)	2526 (41.9)	<0.001	2932 (39.1)	1774 (40.7)	<0.001
11 to 20	3909 (40.3)	2392 (39.7)		2934 (39.1)	1712 (39.2)	
21 to 30	1165 (12)	669 (11.1)		968 (12.9)	524 (12.0)	
31 to 40	358 (3.7)	203 (3.4)		338 (4.5)	176 (4.0)	
41 to 50	141 (1.5)	86 (1.4)		121 (1.6)	68 (1.6)	
51+	239 (2.5)	148 (2.5)		211 (2.8)	109 (2.5)	
T Stage						
1	7783 (80.3)	4909 (81.5)	<0.001	5855 (78)	3484 (79.9)	<0.001
2	1637 (16.9)	941 (15.6)		1402 (18.7)	754 (17.3)	
3	221 (2.3)	140 (2.3)		191 (2.5)	103 (2.4)	
4	56 (0.6)	34 (0.6)		56 (0.7)	22 (0.5)	
N Stage						
0	8202 (84.6)	5171 (85.8)	<0.001	6478 (86.3)	3833 (87.9)	<0.001
1	1234 (12.7)	714 (11.9)		845 (11.3)	442 (10.1)	
2	173 (1.8)	86 (1.4)		115 (1.5)	54 (1.2)	
3	88 (0.9)	53 (0.9)		66 (0.9)	34 (0.8)	
Grade						
I	3457 (35.7)	2192 (36.4)	0.010	2671 (35.6)	1628 (37.3)	<0.001
II	5194 (53.6)	3223 (53.5)		4065 (54.2)	2344 (53.7)	
III	1046 (10.8)	609 (10.1)		768 (10.2)	391 (9.0)	
Histology						
Ductal	7667 (79.1)	4741 (78.7)	<0.001	5916 (78.8)	3426 (78.5)	0.039
Lobular	1454 (15.0)	959 (15.9)		1199 (16.0)	728 (16.7)	
Mixed	576 (5.9)	324 (5.4)		389 (5.2)	209 (4.8)	

AJCC Stage						
I	8330 (85.9)	5395 (89.6)	<0.001	6306 (84)	3870 (88.7)	<0.001
II	1073 (11.1)	477 (7.9)		935 (12.5)	379 (8.7)	
III	225 (2.3)	116 (1.9)		192 (2.6)	77 (1.8)	
IV	69 (0.7)	36 (0.6)		71 (0.9)	37 (0.8)	
Age at diagnosis						
67-69	3606 (37.2)	2182 (36.2)	0.013			
70-74	6091 (62.8)	3842 (63.8)				
75-79				4197 (55.9)	2520 (57.8)	<0.001
80-84				2197 (29.3)	1283 (29.4)	
85+				1110 (14.8)	560 (12.8)	
Race and ethnicity						
Non-Hispanic White	7840 (80.8)	5039 (83.6)	<0.001	6318 (84.2)	3833 (87.9)	<0.001
Non-Hispanic Black	577 (6)	293 (4.9)		448 (6)	203 (4.7)	
Asian	430 (4.4)	214 (3.6)		306 (4.1)	137 (3.1)	
Hispanic	461 (4.8)	231 (3.8)		291 (3.9)	129 (3.0)	
Other/Unknown	389 (4)	247 (4.1)		141 (1.9)	61 (1.4)	
Marital status						
Single/Unmarried	3682 (38)	2186 (36.3)	<0.001	3900 (52)	2200 (50.4)	<0.001
Married	5634 (58.1)	3611 (59.9)		3294 (43.9)	2008 (46.0)	
Missing	381 (3.9)	227 (3.8)		310 (4.1)	155 (3.6)	
Medicare/Medicaid dual eligible						
No	8734 (90.1)	5604 (93.0)	<0.001	6804 (90.7)	4125 (94.5)	<0.001
Yes	963 (9.9)	420 (7.0)		700 (9.3)	238 (5.5)	
Area-level median income						
<$60k/yr	4328 (44.6)	2563 (42.5)	<0.001	3345 (44.6)	1810 (41.5)	<0.001
$60-<$110k/yr	4380 (45.2)	2798 (46.4)		3348 (44.6)	2024 (46.4)	
$110k/yr+	989 (10.2)	663 (11.0)		811 (10.8)	529 (12.1)	

Area-Level Percent of Black Residents						
0-5%	6359 (65.6)	4039 (67.0)	<0.001	4825 (64.3)	2920 (66.9)	<0.001
5%-14%	1889 (19.5)	1152 (19.1)		1478 (19.7)	833 (19.1)	
>=15%	1449 (14.9)	833 (13.8)		1201 (16)	610 (14.0)	
Percentage of Residents Residing in Urban Area						
≥50% in Urban	8220 (84.8)	5176 (85.9)	<0.001	6480 (86.4)	3815 (87.4)	0.001
<50% in Urban	1477 (15.2)	848 (14.1)		1024 (13.6)	548 (12.6)	
Frailty						
Not Frail	8351 (86.1)	5271 (87.5)	<0.001	5774 (76.9)	3439 (78.8)	<0.001
Frail	1346 (13.9)	753 (12.5)		1730 (23.1)	924 (21.2)	
Elixhauser comorbidity index						
No comorbidities	4242 (43.7)	2686 (44.6)	0.002	2449 (32.6)	1435 (32.9)	0.567
1-2 comorbidities	3782 (39.0)	2362 (39.2)		3098 (41.3)	1810 (41.5)	
3 or more comorbidities	1673 (17.3)	976 (16.2)		1957 (26.1)	1118 (25.6)	
Any prior screening in 2 years prior to diagnosis						
Yes	5891 (60.8)	3818 (63.4)	<0.001	4569 (60.9)	2801 (64.2)	<0.001
No	3806 (39.2)	2206 (36.6)		2935 (39.1)	1562 (35.8)	
Any PCP visit in 2 years prior to diagnosis						
Yes	8364 (86.3)	5205 (86.4)	0.601	6793 (90.5)	3991 (91.5)	0.001
No	1333 (13.7)	819 (13.6)		711 (9.5)	372 (8.5)	
Annual Wellness Visit in 2 years prior to diagnosis						
Yes	4092 (42.2)	2756 (45.8)	<0.001	3182 (42.4)	2058 (47.2)	<0.001
No	5605 (57.8)	3268 (54.2)		4322 (57.6)	2305 (52.8)	

Flu shot in 2 years prior to diagnosis						
Yes	6243 (64.4)	3974 (66.0)	<0.001	5396 (71.9)	3259 (74.7)	<0.001
No	3454 (35.6)	2050 (34.0)		2108 (28.1)	1104 (25.3)	
Year of diagnosis						
2015	1121 (11.6)	297 (4.9)	<0.001	935 (12.5)	212 (4.9)	<0.001
2016	1269 (13.1)	497 (8.3)		1095 (14.6)	377 (8.6)	
2017	1332 (13.7)	699 (11.6)		1001 (13.3)	468 (10.7)	
2018	1432 (14.8)	876 (14.5)		1124 (15)	640 (14.7)	
2019	1619 (16.7)	1147 (19.0)		1197 (16)	856 (19.6)	
2020	1250 (12.9)	1045 (17.3)		903 (12)	719 (16.5)	
2021	1674 (17.3)	1463 (24.3)		1249 (16.6)	1091 (25.0)	

*P-values for unadjusted chi-square tests assessing the association between each covariate and screening modality (DBT vs. DM) within each age group

Figures

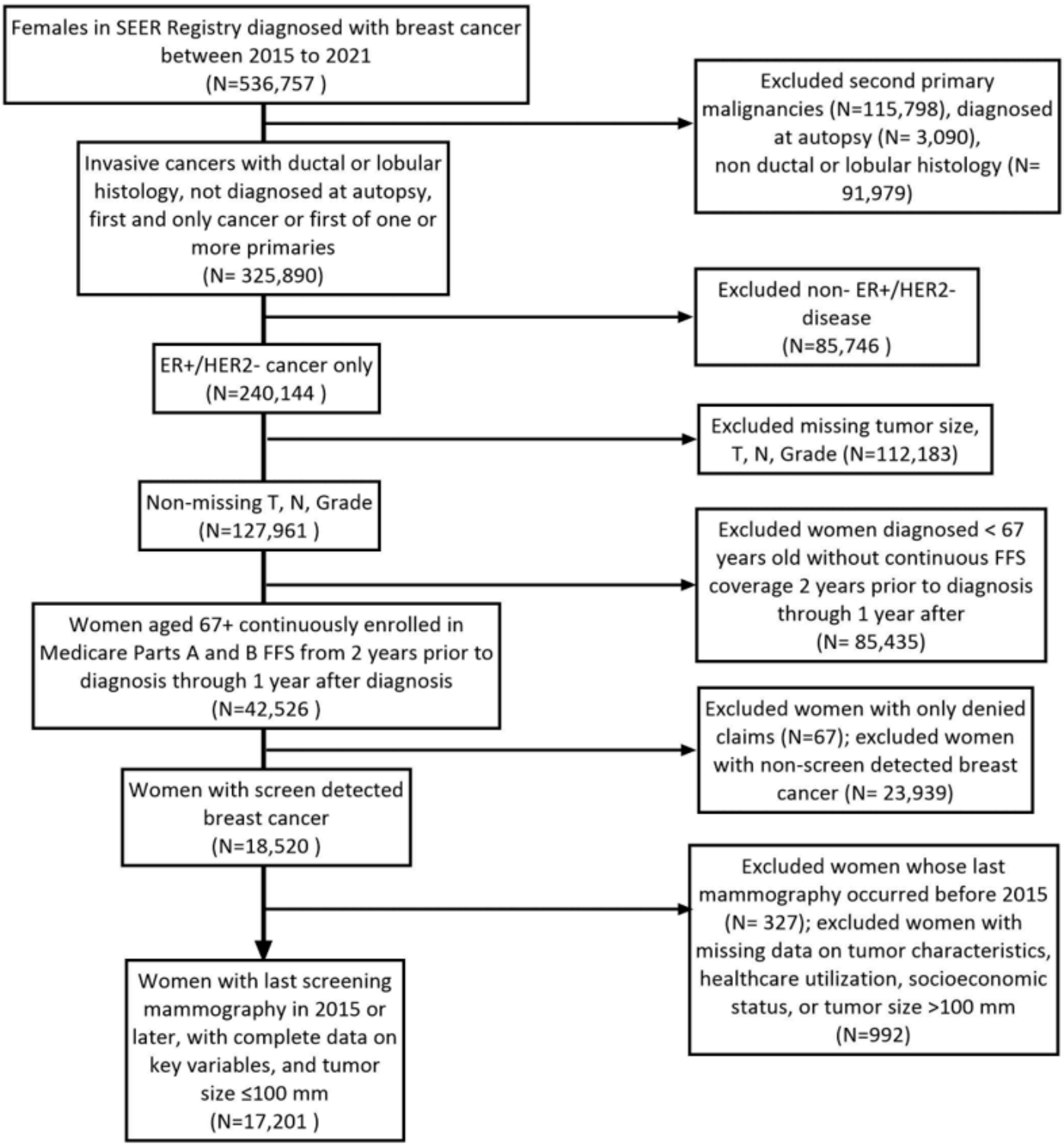

Figure 1

Flow Diagram for Cohort Construction

Abbreviations: FFS = Fee-for Service; ER+ = Estrogen Receptor Positive; HER2- = Human Epidermal Growth Factor Receptor 2 Negative.

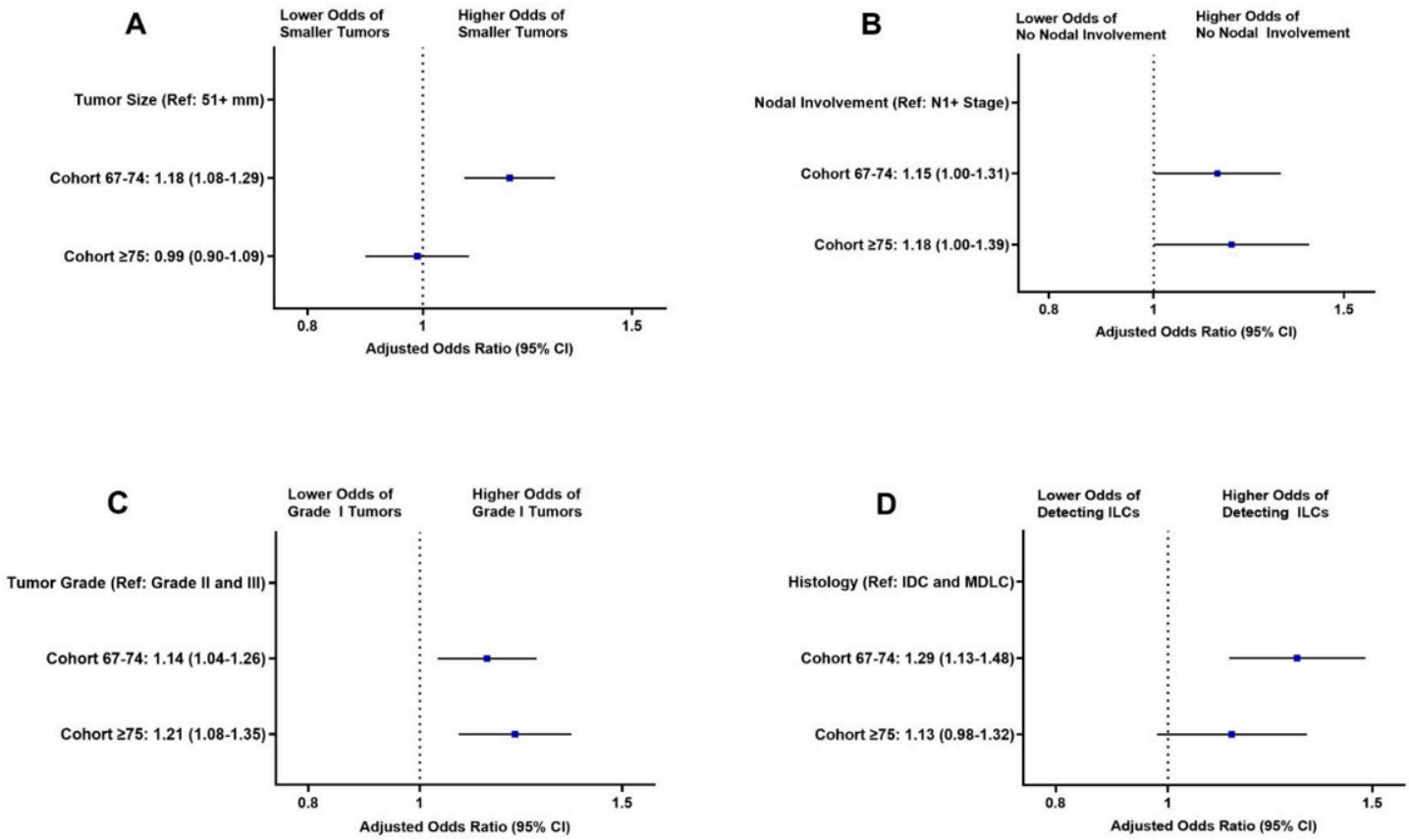

Figure 2

Adjusted Associations between Tumor Characteristics and Screening Modality

Models were adjusted for demographic factors (age, race/ethnicity, marital status); socioeconomic indicators (Medicare and Medicaid dual eligibility; area-level percentage Black residents, urbanicity, median household income); year of diagnosis; clinical factors (claims-based frailty index, Elixhauser comorbidities); healthcare utilization in the prior 2 years (prior screening mammogram, primary care visit, flu vaccination, Annual Wellness Visit); and the three tumor characteristics not used as the outcome (tumor size, nodal status, grade, histology, adjusting for the other three in each model). Abbreviations: ILC = Invasive Lobular Carcinoma; IDC = Invasive Ductal Carcinoma; MDLC = Mixed Lobular Ductal Carcinoma; CI = Confidence Interval.

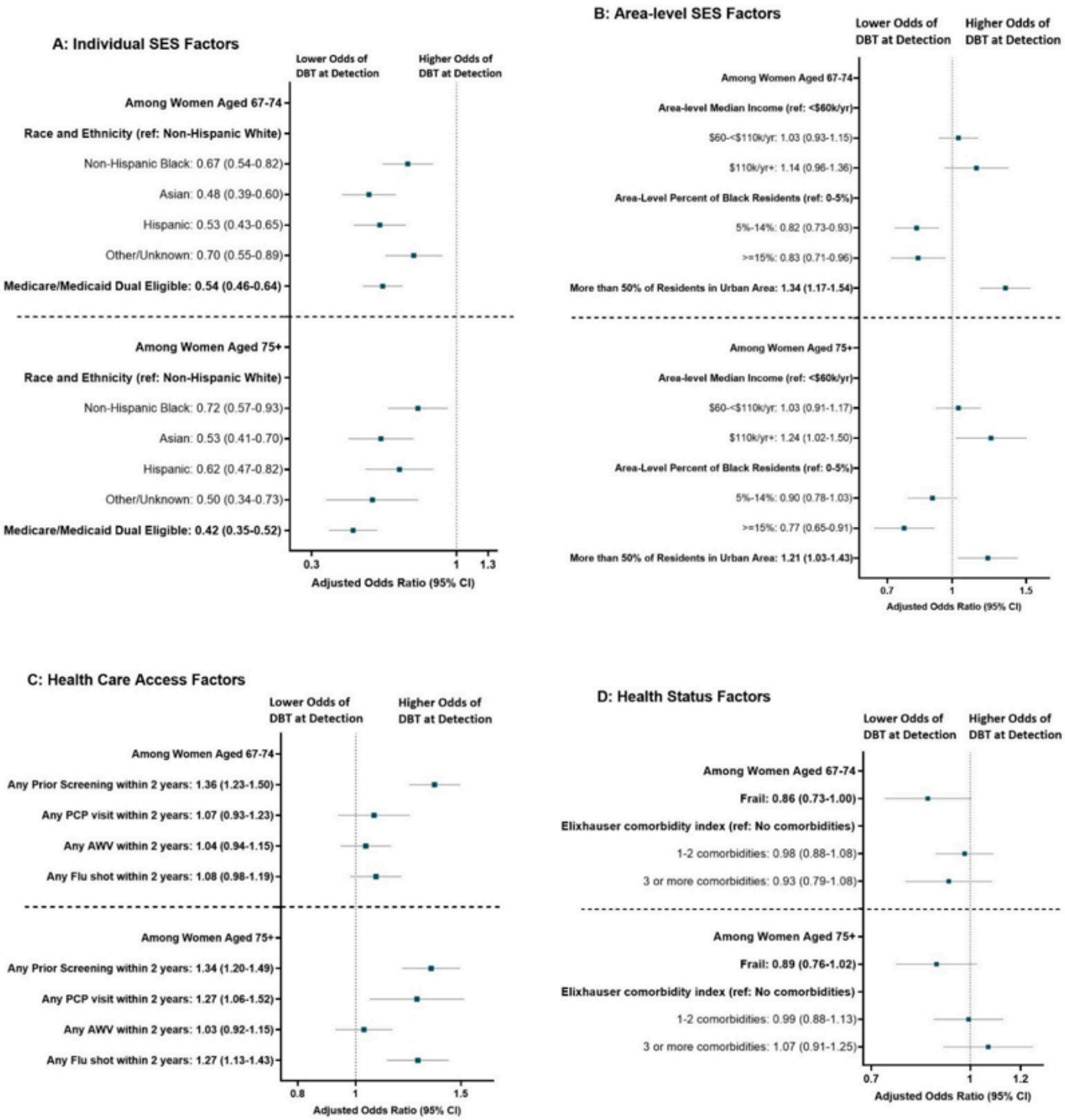

Figure 3

Adjusted Associations Between Patient Characteristics and Screening Modality

Abbreviations: SES = Socioeconomic Status; PCP = Primary Care Physician; AWV = Annual Wellness Visit; CI = Confidence Interval.

Supplementary Files

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