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ORIGINAL REPORT

Use of Surveillance Mammography Among Older Breast Cancer Survivors by Life Expectancy

Rachel A. Freedman, Nancy L. Keating, Lydia E. Pace, Joyce Lii, Ellen P. McCarthy, and Mara A. Schonberg

Author affiliations and support information (if applicable) appear at the end of this article.

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Corresponding author: Rachel A. Freedman, MD, MPH, Dana-Farber Cancer Institute, 450 Brookline Ave, Boston, MA; e-mail: rafreedman@partners.org.

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ABSTRACT

Purpose
The benefits of annual surveillance mammography in older breast cancer survivors with limited life expectancy are not known, and there are important risks; however, little is known about mammography use among these women.

Materials and Methods
We used National Health Interview Study data from 2000, 2005, 2008, 2010, 2013, and 2015 to examine surveillance mammography use among women age ≥ 65 years who reported a history of breast cancer. Using multivariable logistic regression, we assessed the probability of mammography within the last 12 months by 5- and 10-year life expectancy (using the validated Schonberg index), adjusting for survey year, region, age, marital status, insurance, educational attainment, and indicators of access to care.

Results
Of 1,040 respondents, 33.7% were age ≥ 80 years and 88.6% were white. Approximately 8.6% and 35.1% had an estimated life expectancy of ≤ 5 and ≤ 10 years, respectively. Overall, 78.9% reported having routine surveillance mammography in the last 12 months. Receipt of mammography decreased with decreasing life expectancy ($P < .001$), although 56.7% and 65.9% of those with estimated ≤ 5-year and ≤ 10-year life expectancy, respectively, reported mammography in the last year. Conversely, 14.1% of those with life expectancy > 10 years did not report mammography. In adjusted analyses, lower (*v* higher) life expectancy was significantly associated with lower odds of mammography (odds ratio, 0.4; 95% CI, 0.3 to 0.8 for ≤ 5-year life expectancy and OR, 0.4; 95% CI, 0.3 to 0.6 for ≤ 10-year life expectancy).

Conclusion
Many (57%) older breast cancer survivors with an estimated short life expectancy (< 5 years) receive annual surveillance mammography despite unknown benefits, whereas 14% with estimated life expectancy > 10 years did not report mammography. Practice guidelines are needed to optimize and tailor follow-up care for older patients.

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INTRODUCTION

The US population is aging, and the number of older women who will develop breast cancer is expected to increase by 50% between 2010 and 2030.[1] Currently, approximately 70,000 US women age ≥ 70 years are diagnosed with breast cancer annually,[2] many living years beyond their cancer diagnoses and most dying from non–breast cancer causes.[3,4]

Recommendations for screening mammography in the United States have evolved in recent years, with increasing acknowledgment of the limitations in applying uniform screening guidelines to all women.[5,6] For average-risk women without a history of breast cancer, the American Cancer Society currently recommends cessation of screening mammography for women with < 10-year life expectancy.[6,7] Despite these guidelines, discussions surrounding cessation of screening mammography are challenging and happen infrequently.[8-11] Likely as a result, screening mammography rates for women have remained stable over time, regardless of age,[12,13] even among those with limited life expectancy. In 2010, 36% of women with < 5-year life expectancy reported having had screening mammography within the last 2 years.[14,15]

With regard to surveillance mammography, recently updated guidelines from the Older Adult

ASSOCIATED CONTENT

Appendix
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Oncology National Comprehensive Cancer Network state that mammography decisions in older breast cancer survivors should be primarily based on patient preference and life expectancy, with likely no benefit to screening women with ≤ 5-year life expectancy.[16] In contrast, and as a result of a lack of prospective data to guide strategies, Breast Cancer Survivorship guidelines from the American Cancer Society and ASCO currently recommend annual mammography for all breast cancer survivors who have residual breast tissue, regardless of age or life expectancy.[17,18] There are no studies specifically examining the benefits of surveillance mammography in older breast cancer survivors, let alone those with limited life expectancy, and the use of mammography in this growing population of patients has been questioned.[14,19-21]

Among women without a history of breast cancer, it is estimated to take > 10 years before one breast cancer death is prevented among 1,000 women age 50 to 74 years mammographically screened.[22] Although the lag time to benefiting from mammography screening among breast cancer survivors is not known, it is likely similar. However, there are risks of screening that occur immediately, including anxiety and complications related to the evaluation of false-positive tests and overdiagnosis (detection of tumors that are of no threat).[6,14,23-27] Therefore, older women with limited life expectancies who undergo surveillance mammography are unlikely to experience benefit and may instead place themselves at risk for harm.

Given the lack of data to clearly guide surveillance mammography in older breast cancer survivors, it is not surprising that mammography use in older breast cancer survivors is highly variable.[28,29] In a study of older women with stage I or II breast cancer during 1992 to 1999 who were insured by Medicare, 77.6% underwent mammography during months 7 to 18 after diagnosis, and 56.7% had mammography annually over the 3 years after diagnosis. Lower use of mammography was observed with increasing age, black race, more comorbidity, unmarried status, and certain geographic regions, whereas those with more frequent oncology provider visits had more imaging.[28] High rates of surveillance mammography in the first year after treatment of in situ breast cancers (91.3%) with lower rates over time were also observed in a Medicare population (age ≥ 65 years) during 1992 to 2005, with highest rates among those with more provider visits.[29] However, the use of surveillance mammography by life expectancy has not been previously described.

To better understand use of surveillance mammography among older women with varying life expectancy, we used National Health Interview Survey (NHIS) data from 2000 to 2015 to examine the proportion of older breast cancer survivors having routine surveillance mammography in the past year by 5- and 10-year life expectancy.[15,30-32]

MATERIALS AND METHODS

Data Source

The NHIS is a large, nationally representative, in-person household interview survey of noninstitutionalized US civilians conducted annually by the Census Bureau for the National Center for Health Statistics.[33] NHIS collects information on participants' demographics, health history, and medical services used. The NHIS sampling design uses stratification, clustering, and oversampling of specific subgroups.[34] Within households, one adult per family is randomly selected to complete questionnaires. We used NHIS data on sampled adults from 2000, 2005, 2008, 2010, 2013, and 2015 because of the availability of the Person, Sample Adult, and/or Sample Adult Cancer files during these years, which contain information on cancer history, mammography use, and other health information relevant to this analysis. The final sample adult response rates (interviewed sample adults/eligible sample adults from interviewed families × final family response rate) by year were 72.1% (2000), 69.0% (2005), 62.6% (2008), 60.8% (2010), 61.2% (2013), and 55.2% (2015).[33] Proxy respondents are not allowed in the adult sample except in extreme cases (< 1% annually) wherein the sampled adults are mentally or physically unable to respond for themselves. We excluded these cases and included only self-responders. The study was deemed exempt from review by the Office for Human Research Studies at Dana-Farber Cancer Institute (Boston, MA).

Participants

Among 180,969 respondents to the sample adult questionnaire during 2000, 2005, 2008, 2010, 2013, and 2015, we identified 1,695 women who were age ≥ 65 years and who reported having a history of breast cancer (defined reporting a history of breast cancer, having a cancerous lump removed from the breast, or by answering yes to the question: "as a result of these additional tests after your mammogram[s], were you diagnosed with cancer?"). We excluded women who refused to answer, had missing information, or said "I don't know" to whether they had a mammogram (n = 60) and 514 women who stated they had a mammogram in the last year for reasons other than for screening ("because of a problem" [n = 412], "other reason" or "to follow up on a previously identified breast problem" [n = 88], "refused" [n = 3], "not ascertained" [n = 1], or "don't know" [n = 10]). Last, we excluded 40 women who did not report a clearly defined time interval since their last mammogram and 41 women who had missing/unknown information for any variable required to calculate life expectancy. The final analytic cohort included 1,040 women (Fig 1).

Outcome of Interest

Our primary outcome of interest was self-reported receipt of mammography within the last 12 months. The variables used to construct this outcome by year are shown in Appendix Table A1 (online only). We adapted prior definitions of mammography use within the NHIS.[12,13,15]

Independent Variable of Interest

For each woman, we estimated 5- and 10-year life expectancy using the validated Schonberg index.[15,30-32] This index was developed and validated using NHIS data and includes 11 risk factors independently and significantly associated with mortality, including age, sex, cigarette use, body mass index, functional limitations, difficulty with mobility, the number of hospitalizations in the past year, perceived health, and history of emphysema, diabetes, and cancer (excluding nonmelanoma skin cancers). In addition, because our study focused exclusively on women with breast cancer, we were interested in a woman's non–breast cancer–related mortality risk, and thus in our primary analyses we did not include history of breast cancer in our measure for history of cancer. However, in sensitivity analyses, we repeated analyses including history of breast cancer in our measure for history of cancer. On the basis of the presence or absence of these 11 risk factors, we calculated a life expectancy score for each respondent. Because life expectancy is the average survival of a population, we considered women with > 50% 5-year mortality risk (defined as ≥ 15 points) to have a life expectancy ≤ 5 years, and we considered women with > 50% 10-year mortality risk (≥ 10 points) to have a life expectancy ≤ 10 years.[15,30-32]

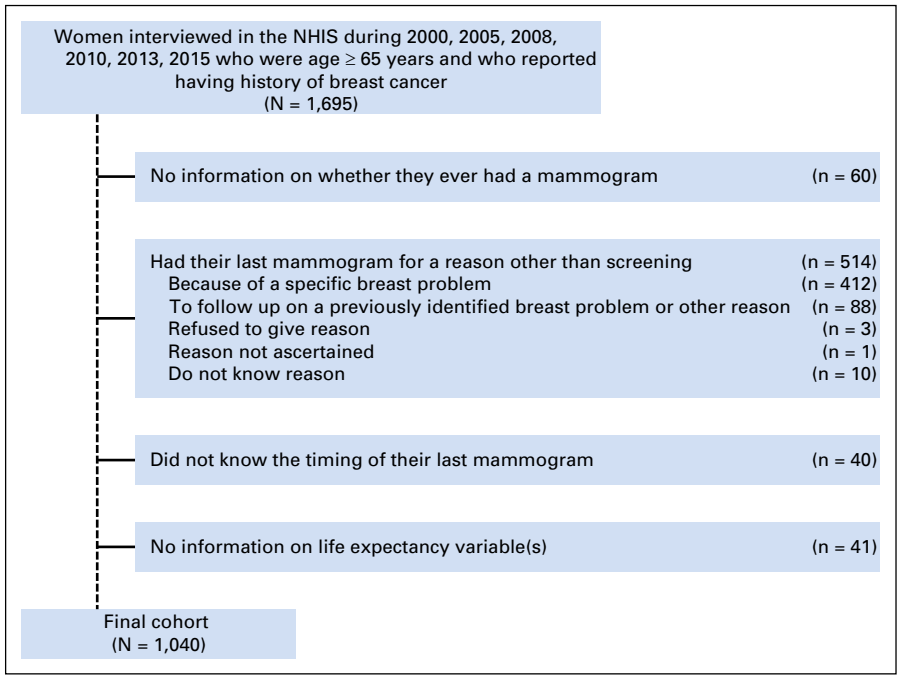

Fig 1. Cohort inclusions/exclusions. NHIS, National Health Interview Survey.

Covariates

We considered the following factors that have previously been shown to be associated with mammography use among older women, including age, race/ethnicity, educational attainment, geographical region, marital status, insurance, number of provider visits in the last year, and the usual source of care in the last 12 months (ie, specialists or primary care clinicians).[14,15] We also included survey year in analyses, categorizing this into three intervals because of the relatively smaller sample sizes in some years (2000 and 2005, 2008 and 2010, 2013 and 2015). All variables were categorized as presented in Table 1.

Statistical Analysis

We compared mammography receipt within the last 12 months for all women by each patient characteristic, including estimated life expectancy and each of its contributing factors, using χ^2 tests. We then performed multivariable logistic regression to estimate the probability of having mammography in the last 12 months by 5- and 10-year life expectancy, adjusting for the covariates listed above. In sensitivity analyses, we first repeated models after categorizing all women in the cohort as having a prior cancer. To account for any issues in ascertainment of reasons for mammography (eg, if a woman interpreted having a routine mammogram after breast cancer as having testing to address a breast problem), we also repeated the models after including the 490 women excluded because they provided reasons other than screening for their mammography and who met other eligibility criteria (ie, 24 of 513 women were still excluded in sensitivity analyses for having incomplete mortality index variables). Analyses were performed using SAS survey procedures version 9.4 (SAS Institute, Cary, NC) to account for the complex sampling design, and data were weighted to reflect national estimates.[34]

RESULTS

The cohort characteristics for the 1,040 women with a history of breast cancer are shown in Table 1. Most women were white (88.6%) and at least high school graduates (85.8%), and many were actively engaged in health care, with 46.4% reporting having seen a health care provider six or more times over the last year. With regard to the variables contributing to life expectancy calculations, 33.7% were age ≥ 80 years, 41.3% reported excellent/very good health, and 82.4% had not been hospitalized in the last year. Few reported having chronic lung disease, diabetes, or prior non-breast cancer. About half (50.5%) of women reported no difficulty walking one fourth of a mile. After summing life expectancy scores, 8.6% and 35.0% had life expectancies of ≤ 5 years and ≤ 10 years, respectively.

Overall, 78.9% of women reported having surveillance mammography in the last 12 months (Table 1). Married status, having more provider visits, increasing age, reporting excellent/very good health, and reporting no difficulty with instrumental activities of daily living and no difficulty with walking one fourth of a mile were all significantly associated with higher mammography use (all $P < .05$). More than half (56.7%) of women with ≤ 5-year life expectancy and 65.9% of women with ≤ 10-year life expectancy had surveillance mammography in the past year. Conversely, 14.1% of women with > 10-year life expectancy did not report recent surveillance mammography (Fig 2).

In adjusted analyses (Table 2), having a lower estimated life expectancy remained significantly associated with lower odds of surveillance mammography in the last 12 months (adjusted odds ratio [OR], 0.4; 95% CI, 0.3 to 0.8 for those with ≤ 5-year life expectancy and OR, 0.4; 95% CI, 0.3 to 0.6 for those with ≤ 10-year life expectancy [both *v* higher estimated life expectancy]). Other factors associated with higher odds of surveillance mammography included being married/partnered (*v* single), having a high school diploma (*v* not), and having more provider visits. Increasing age was associated with lower odds of having mammography but was significant in models examining 5-year life expectancy only. In sensitivity analyses done after recalculation of mortality scores, even more women with limited life expectancy (60.8% and 70.0% of women with ≤ 5-year and ≤ 10-year life expectancy) had mammography. After including women having mammography regardless

Table 1. Cohort Characteristics by Receipt of Surveillance Mammography in the Last 12 Months (n = 1,040, representing 1,030,892 US women)

Characteristic	Overall Sample No. (unweighted)	Weighted % of Cohort (SE)	Surveillance Mammography in Last 12 Months: Unweighted No. Having Mammography	Surveillance Mammography in Last 12 Months: Weighted no. Having Mammography	Surveillance Mammography in Last 12 Months: Weighted % Having Mammography (SE)	Weighted *P*[a]
Overall	1,040	100	782	813,165	78.9	—
Survey year						.076
2000 and 2005	291	25.1 (1.4)	230	207,809	80.2 (2.6)	
2008 and 2010	265	32.0 (1.9)	214	272,647	82.7 (2.6)	
2013 and 2015	484	42.9 (2.0)	338	332,709	75.2 (2.5)	
Region						.481
Northeast	170	18.2 (1.6)	124	148,230	78.8 (4.0)	
Midwest	265	26.7 (1.5)	207	217,559	79.0 (3.3)	
South	369	35.5 (1.8)	286	298,009	81.3 (2.2)	
West	236	19.6 (1.4)	165	149,367	74.2 (3.7)	
Race/ethnicity						.668
Non-Hispanic white	865	88.6 (1.1)	647	721,335	79.0 (1.7)	
Non-Hispanic black	93	5.4 (0.7)	74	45,382	81.3 (4.6)	
Other	82	6.0 (1.0)	61	46,449	74.6 (6.5)	
Marital status						.001
Single/divorced/widowed/unknown	693	51.1 (1.9)	501	386,725	73.5 (2.3)	
Married/with partner	347	48.9 (1.9)	281	426,440	84.5 (2.2)	
Insurance						.221
Medicare, private, HMO, other	958	93.9 (0.8)	724	768,001	79.3 (1.6)	
No insurance, Medicare Part A only, or Medicaid	82	6.1 (0.8)	58	45,164	72.3 (6.0)	
Educational attainment						.049
Less than high school diploma	177	14.3 (1.3)	122	103,808	70.5 (4.0)	
High school graduate	346	33.2 (1.8)	269	284,293	83.1 (2.2)	
Some college	281	28.5 (1.8)	210	224,769	76.5 (3.4)	
Bachelor's degree or higher	236	24.1 (1.7)	181	200,295	80.8 (3.2)	
No. of provider visits in last 12 months[15b]						.026
0-1	96	9.3 (1.1)	59	62,795	65.6 (5.9)	
2-5	465	44.2 (2.0)	352	363,001	79.5 (2.5)	
≥ 6	479	46.4 (2.1)	371	387,370	80.9 (2.1)	
Usual source of care received in the last 12 months[15c]						.503
General practitioner, outpatient clinic	977	94.2 (0.9)	738	768,044	79.1 (1.6)	
Specialist care, or no usual place for care	63	5.8 (0.9)	44	45,121	75.0 (6.3)	
Life expectancy variables[d]						
Age, years						< .001
65-69	227	23.3 (1.7)	188	206,947	86.2 (2.9)	
70-74	222	24.2 (1.8)	179	211,433	84.7 (3.0)	
75-79	206	18.8 (1.5)	161	158,388	81.8 (3.1)	
80-84	216	19.5 (1.5)	157	147,323	73.2 (4.1)	
≥ 85	169	14.2 (1.2)	97	89,074	60.9 (5.0)	
Body mass index						.167
< 25	433	42.5 (1.8)	312	333,892	76.2 (2.5)	
≥ 25	607	57.5 (1.8)	470	479,273	80.8 (2.1)	
General health						.007
Excellent/very good	413	41.3 (2.0)	319	354,140	83.2 (2.3)	
Good	398	38.3 (2.0)	303	311,029	78.8 (2.4)	
Fair/poor	229	20.4 (1.5)	160	147,997	70.3 (3.6)	
Ever diagnosed with COPD or emphysema?[e]						.769
Yes	36	4.1 (0.8)	23	32,315	76.8 (7.5)	
No	1004	95.9 (0.8)	759	780,850	79.0 (1.6)	
Ever diagnosed with cancer[f]						.819
Yes	150	14.3 (1.3)	109	117,043	79.7 (3.3)	
No	890	85.7 (1.3)	673	696,122	78.8 (1.8)	
Ever diagnosed with diabetes?[g]						.357
Yes	224	22.1 (1.6)	166	173,371	76.2 (3.6)	
No	816	77.9 (1.6)	616	639,794	79.6 (1.7)	
Do you have difficulty with IADLs?						< .001
Yes	146	12.8 (1.2)	89	81,056	61.3 (5.2)	
No	894	87.2 (1.2)	693	732,109	81.5 (1.5)	
Ease of walking 1/4 mile						.001
Not at all difficult	515	50.5 (1.9)	412	440,829	84.6 (1.8)	
A little difficult or very difficult	273	26.6 (1.8)	206	208,857	76.1 (3.5)	
Cannot do/do not do	252	22.8 (1.6)	164	163,479	69.4 (3.7)	

(continued on following page)

Table 1. Cohort Characteristics by Receipt of Surveillance Mammography in the Last 12 Months (n = 1,040, representing 1,030,892 US women) (continued)

Characteristic	Overall Sample No. (unweighted)	Weighted % of Cohort (SE)	Surveillance Mammography in Last 12 Months: Unweighted No. Having Mammography	Surveillance Mammography in Last 12 Months: Weighted no. Having Mammography	Surveillance Mammography in Last 12 Months: Weighted % Having Mammography (SE)	Weighted *P*[a]
Smoking status						.967
Never smoker	640	61.3 (2.0)	486	497,846	78.8 (2.0)	
Former smoker	338	33.2 (1.9)	249	269,687	78.8 (2.6)	
Current smoker	62	5.5 (0.8)	47	45,632	80.4 (5.7)	
No. hospitalizations in the last 12 months[h]						.100
0	851	82.4 (1.5)	647	682,071	80.3 (1.6)	
1	130	12.0 (1.3)	90	87,092	70.1 (5.6)	
2+	59	5.6 (0.9)	45	44,003	76.4 (6.3)	
5-year life expectancy[i]						< .001
Mortality risk ≤ 50% (score < 15)	951	91.4 (1.0)	728	762,663	81.0 (1.5)	
Mortality risk > 50% (score ≥ 15)	89	8.6 (1.0)	54	50,502	56.7 (6.9)	
10-year mortality risk[i]						< .001
Mortality risk ≤ 50% (score < 10)	653	65.0 (1.8)	537	574,907	85.9 (1.6)	
Mortality risk > 50% (score ≥ 10)	387	35.0 (1.8)	245	238,258	65.9 (3.0)	

NOTE. Weighted number and weighted percents reflect population estimates.
Abbreviations: COPD, chronic obstructive pulmonary disease; HMO, Healthcare Maintenance Organization; IADL, instrumental activities of daily living.
[a]By χ^2 testing.
[b]The six participants with unknown number of visits were categorized as 0-1.
[c]The seven patients with no usual place of care were combined with specialist care.
[d]Using previous life expectancy models and definitions.[15,30-32]
[e]COPD variable available for 2013 and 2015; emphysema and bronchitis variables available every year.
[f]Prior cancer defined as any other cancer aside from breast (and excluding testis, prostate, and nonmelanoma skin cancer). For this variable, we summarized all prior cancer variables into one variable, so that anyone reporting another prior cancer(s) was coded as yes and the rest were coded as no. We categorized missing/unknown/refused information as no prior cancer, given the rarity of prior cancer and unknown variables.
[g]Included borderline as having diabetes.
[h]If participants answered yes to being hospitalized in the last year, but the number of hospitalizations was unknown/missing, this was categorized as having one hospitalization.
[i]Based on summing scores for each participant across all categories.[15,30-32]

of reasoning, 56.1% and 66.3% with ≤ 5-year and ≤ 10-year life expectancy had mammography. Results from adjusted models were similar to primary analyses (data not shown).

DISCUSSION

In this population-based analysis of older breast cancer survivors, we found that surveillance mammography use decreased with advancing age and declining life expectancy, with nearly 80% of women having surveillance mammography in the last year. However, 56.7% of women with ≤ 5-year life expectancy (who are unlikely to benefit from mammography) and 65.9% of those with ≤ 10-year life expectancy (who likely have little chance of benefit) reported having a mammogram in the past year. Meanwhile, 14.1% of older breast cancer survivors with > 10-year life expectancy did not have surveillance mammography, even though they are likely to live long enough to benefit from testing. Our findings suggest the need to improve the tailoring of recommendations for surveillance mammography among older women with a history of breast cancer, especially for those with limited life expectancy. Moreover, strategies are needed to inform breast cancer survivors with a short life expectancy when they may stop being screened without a detrimental effect on breast cancer–related mortality.

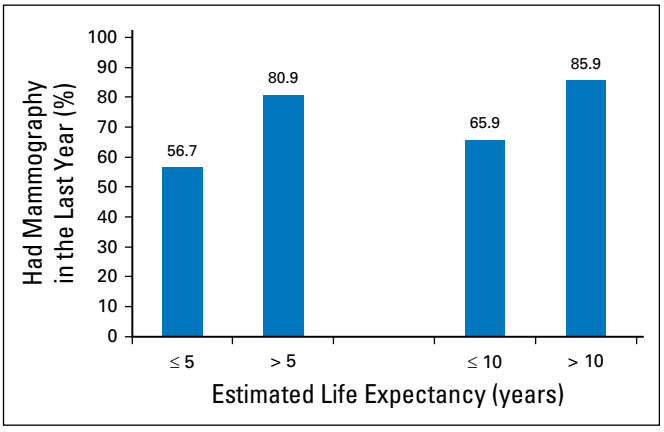

Fig 2. Proportion of women who received surveillance mammogram in the last year by life expectancy (n = 1,040, representing 1,030,892 US women). $P < .001$ for both comparisons of surveillance mammography by life expectancy using the χ^2 test.

Previous studies have also reported high use of mammography in older breast cancer survivors.[28] Use of surveillance mammography may be high among older women with limited life expectancy because guidelines have not provided consistent strategies for cessation of surveillance mammography[16-18] (and in particular the National Comprehensive Cancer Network Older Adult Guidelines[16] did not provide input on surveillance until 2016). Also, women with a history of breast cancer (and their providers) often find annual mammograms reassuring because of concerns for an increased risk for in-breast events or increased anxiety related to past diagnoses. Furthermore, providers may not extrapolate the uncertainties of benefit for mammographic

Table 2. Adjusted Odds of Having a Surveillance Mammogram in the Last Year Among Breast Cancer Survivors Age ≥ 65 years by 5- and 10-Year Life Expectancy

Variable*	5-Year Life Expectancy Model		10-Year Life Expectancy Model	
	Adjusted OR†	95% CI	Adjusted OR†	95% CI
5-year life expectancy			—	—
Mortality risk ≤ 50% (score < 15)	—	—		
Mortality risk > 50% (score ≥ 15)	**0.4**	**0.3 to 0.8**		
10-year life expectancy	—	—		
Mortality risk ≤ 50% (score < 10)			—	—
Mortality risk > 50% (score ≥ 10)			**0.4**	**0.3 to 0.6**
Survey year				
2000 and 2005	—	—	—	—
2008 and 2010	1.2	0.8 to 1.9	1.2	0.8 to 1.8
2013 and 2015	0.7	0.5 to 1.0	0.8	0.5 to 1.0
Region				
Northeast	—	—	—	—
Midwest	0.9	0.5 to 1.6	0.9	0.5 to 1.7
South	1.1	0.7 to 1.7	1.1	0.7 to 1.8
West	0.8	0.5 to 1.5	0.8	0.5 to 1.5
Race/ethnicity				
Non-Hispanic white	—	—	—	—
Non-Hispanic black	1.1	0.7 to 1.9	1.1	0.7 to 1.8
Other	0.7	0.4 to 1.5	0.8	0.4 to 1.6
Marital status				
Single/divorced/widowed/unknown	—	—	—	—
Married/with partner	**1.5**	**1.0 to 2.3**	**1.5**	**1.0 to 2.3**
Insurance				
Medicare, private, HMO, other	—	—	—	—
No insurance, Medicare Part A only, or Medicaid	0.8	0.4 to 1.3	0.8	0.5 to 1.5
Educational attainment				
Less than high school diploma	—	—	—	—
High school graduate	**1.5**	**1.0 to 2.3**	**1.6**	**1.0 to 2.4**
Some college	1.0	0.6 to 1.5	0.9	0.6 to 1.5
Bachelor's degree or higher	1.1	0.7 to 1.8	1.1	0.7 to 1.8
No. of provider visits in last 12 months				
0-1	—	—	—	—
2-5	**1.9**	**1.1 to 3.3**	**1.9**	**1.1 to 3.3**
≥ 6	**2.1**	**1.3 to 3.4**	**2.1**	**1.3 to 3.4**
Usual source of care received in the last 12 months‡				
General practitioner, outpatient clinic	—	—	—	—
Gynecology, specialist care, no usual place for care	0.8	0.4 to 1.4	0.8	0.5 to 1.5
Age, years‡				
65-69	—	—	—	—
70-74	0.9	0.5 to 1.7	0.9	0.5 to 1.8
75-79	0.8	0.4 to 1.4	1.0	0.6 to 1.8
80-84	**0.5**	**0.3 to 0.9**	0.8	0.4 to 1.5
≥ 85	**0.4**	**0.2 to 0.8**	0.6	0.3 to 1.3

NOTE. Bolded results are statistically significant with $P < .05$.
Abbreviations: HMO, Healthcare Maintenance Organization; OR, odds ratio.
*See Table 1 for all variable definitions/categorizations.
†By multivariable logistic regression, adjusted for all variables in the table using survey procedures and weighted to reflect population estimates. Reference groups are listed as the first group in each category.
‡Although age is a component of the life expectancy measure, we also adjusted for age independently in our analyses. We did not further adjust for each component of the life expectancy measure.[31,43]

screening in older women to older breast cancer survivors, leading to indefinite, annual mammography without dialogue in many cases. However, many clinically important breast cancers will present by physical examination alone,[19] and it remains unclear whether the addition of mammography over physical examination alone among the oldest and frailest women meaningfully improves outcomes.

Although we acknowledge the lack of prospective data to guide these discussions, the benefits of routine surveillance breast imaging have recently been called into question for those with limited life expectancy as well as those with a history of lower-risk, hormone receptor–positive breast cancers who are taking hormonal therapy (whose long-term risk for bilateral in-breast events is likely ≤ 10%).[20] In addition, some data suggest that the risk for in-breast and contralateral breast events decreases with increasing age,[35-38] likely further lowering the utility of mammography in many women. Moreover, there are potential and immediate harms of mammography in an aging population that must be considered, including false positives, unnecessary biopsies, and, perhaps most importantly, overdiagnosis, all of which have been well documented in screening populations and may be even more likely in breast cancer survivors because of the lower threshold to

evaluate indeterminate/new findings on mammogram for these patients.[5,23-27,39-41]

To truly individualize follow-up care appropriately for breast cancer survivors, better evidence is needed about the benefits and risks of mammography in older survivors with varying mortality risk to develop consensus and uniform practice with close collaboration between specialists and primary care providers. This will require larger, prospective evaluations of how having or not having mammography impacts breast cancer outcomes and quality of life in this setting. In the meantime, clinicians should make a concerted effort to discuss and personalize the pros and cons of surveillance mammography, focusing on the importance of continued ongoing follow-up, breast awareness and physical examinations, a patient's individualized health priorities, and a promotion of a healthy lifestyle, even if mammography is stopped (or continued at a reduced frequency). We recognize that conversations on cessation of mammography with breast cancer survivors may be particularly challenging because of their personal experiences with cancer. However, if women understand their individualized risks and benefits of testing in this setting, they will at least have the opportunity to make informed decisions rather than have the false security that routine mammograms may indefinitely improve their longevity.

To our knowledge, this large, population-based analysis is the first to examine the use of surveillance mammography by life expectancy and provides important information on current patterns of care and opportunities for improvement. However, we acknowledge several limitations. First, because the timing and use of mammography for routine purposes was ascertained by self-report, it is possible that women did not accurately recall this information, although we found similar results when examining mammography use regardless of reason. Second, we lacked information on patient preferences or conversations with providers about mammography. Third, some patient subgroups were small, limiting generalizability to all survivors, such as nonwhite women and those who were underinsured. Fourth, the measures for life expectancy were validated in the general community-dwelling population and have not been specifically validated in women with a history of breast cancer, where the accuracy of general mortality risk measures have been questioned,[42] although we examined life expectancy with and without inclusion of breast cancer in calculations with similar findings. Fifth, we did not have information on mammography use before the most recent mammogram. Sixth, we lacked information on the timing of breast cancer diagnosis in relation to when mammography occurred, tumor characteristics (including stage), the risk for in-breast recurrences, and use of mammography in the setting of metastatic breast cancer. However, the time since diagnosis should not influence the duration of mammography use, as steady rates of in-breast events occur over time after a diagnosis, without a clear plateau.[35] Finally, the NHIS interviews community-dwelling adults who agree to a lengthy interview, perhaps skewing toward a more engaged and healthier population of cancer survivors. However, our sample included adequate numbers of women with short life expectancy to examine mammography in these women. Furthermore, our results are consistent with others[28,29] that have shown a higher likelihood of mammography with more frequent provider visits, regardless of health status.

In conclusion, we observed high use of surveillance mammography in women with limited life expectancy among a national sample of > 1,000 older breast cancer survivors. Our findings highlight the urgent need for more data on the risks and benefits of mammography surveillance among older women with limited life expectancy so we can better inform patients. Future studies should focus on developing strategies on how best to engage older women with a history of breast cancer in shared decision making and how to best tailor surveillance mammography. This will allow for evidence-based guidelines on use of surveillance mammography in older breast cancer survivors that emphasize who is unlikely to derive benefit from mammography and who is more likely to experience potential harm. Such guidelines can help oncologists and primary care providers engage patients in decision making and help focus our interventions on those that may better promote longevity and well-being.

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AUTHOR CONTRIBUTIONS

Conception and design: Rachel A. Freedman, Nancy L. Keating, Lydia E. Pace, Mara A. Schonberg
Financial support: Rachel A. Freedman
Administrative support: Rachel A. Freedman, Mara A. Schonberg
Collection and assembly of data: Rachel A. Freedman, Joyce Lii, Ellen P. McCarthy
Data analysis and interpretation: All authors
Manuscript writing: All authors
Final approval of manuscript: All authors
Accountable for all aspects of the work: All authors

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Affiliations

Rachel A. Freedman, Dana-Farber Cancer Institute; **Nancy L. Keating** and **Ellen P. McCarthy**, Harvard Medical School; **Nancy L. Keating**, **Lydia E. Pace**, and **Joyce Lii**, Brigham and Women's Hospital; and **Ellen P. McCarthy** and **Mara A. Schonberg**, Department of Medicine, Beth Israel Deaconess Medical Center, Boston, MA.

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Use of Surveillance Mammography Among Older Breast Cancer Survivors by Life Expectancy

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Rachel A. Freedman
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Nancy L. Keating
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Joyce Lii
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Ellen P. McCarthy
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Appendix

Table A1. Definitions for Mammography in the Last 12 Months by Survey Year

Survey Year	Definitions for Having Mammography Within the Last 12 Months ("mammolast1yr" = 1 = yes, "mammolast1yr" = 2 = no)*
2000	if RMAM3 = 1 then MammoLast1YR = 1; else if RMAM3 in (2, 3, 4, 5, 9) then MammoLast1YR = 2;
2005	if RMAM1_YR in (2004, 2005) or RMAM2CA = 1 then MammoLast1YR = 1; else if RMAM2CA in (2, 3, 4, 5, 9) then MammoLast1YR = 2;
2008	if RMAM1_YR in (2007, 2008) or RMAM2CA = 1 then MammoLast1YR = 1; else if RMAM2CA in (2, 3, 4, 5, 9) then MammoLast1YR = 2;
2010	if RMAM3A = 1 or RMAM3B = 1 then MammoLast1YR = 1; else if RMAM3A in (2, 3, 4, 5, 9) or RMAM3B in (2, 3, 4, 5, 9) then MammoLast1YR = 2;
2013	if APSMAM = 1 or RMAM3A = 1 then MammoLast1YR = 1; else if APSMAM in (2, 9) or RMAM3A in (2, 3, 4, 5, 9) then MammoLast1YR = 2;
2015	if RMAM3A = 1 or RMAM3B = 1 then MammoLast1YR = 1; else if RMAM3A in (2, 3, 4, 5, 9) or RMAM3B in (2, 3, 4, 5, 9) then MammoLast1YR = 2;

NOTE. Adapted from prior definitions.[12,13,15]
*Women who could not clearly report the timing of their last mammogram were excluded from the analytic cohort.