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Patterns and predictors of the breast cancer detection methods in women under 45 years of age (United States)

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Abstract

Objectives: Few studies have examined methods by which breast cancers are detected, and only one study has been published on predictors of those methods. This study examined patterns and predictors of breast cancer detection methods during 1990–1992 among women age 20–44.
Methods: In-person interview and medical record data were obtained during a population-based case–control study of 1619 women newly diagnosed with breast cancer in three areas of the United States (US).
Results: Seventy-one percent of the cancers were identified by self-detection, 9% by routine clinical breast exam (CBE), and 20% by routine mammography. Cancers detected by mammography and CBE, but not those detected by breast self-exam, were much more likely to be early-stage. Detection by mammography increased with age, and a history of mammography use was associated with detection by mammography or CBE. Several commonly studied predictors of screening utilization in the US population were associated with CBE detection, but were less clearly related to or unrelated to mammography detection.
Conclusion: Findings suggest that, during the 1990s in the US, most breast cancers among women under age 45, including those age 40–44, were self-detected. Few factors other than age and prior screening are verified predictors of method of breast cancer detection.

Introduction

Because the efficacy of mammography in reducing breast cancer mortality in women age 50–69 is commonly recognized, routine mammographic screening for women in this age range has been generally recommended in the United States (US) since the late 1970s [1–7]. Although the efficacy of clinical breast exams (CBEs) has not been clearly established, indirect evidence indicates that it is may be efficacious [8, 9], in the US. CBE is frequently included with mammography in breast cancer screening recommendations [1–3, 8, 9]. A substantial amount of research has been conducted on predictors of, and barriers to, screening [10–31] and on methods to increase its use [32, 33], and programs have been implemented to increase [34, 35] and monitor [12, 13, 36] utilization in the general population. In addition, there have been a number of studies examining the potential effects of increased screening utilization on changes in both breast cancer incidence [37, 38] and stage at diagnosis [38, 39]. However, although efficacy of mammography has been established in clinical trials, there has been very little research on the effectiveness of breast cancer screening programs in the general population [40], and limited information is available on the proportions of breast cancers among US women that are actually detected by screening [39, 41–44]. There is only one published study [43] of factors that predict methods by which breast cancers are detected. Whether breast cancer is detected during screening (routine mammography or CBE) or is self-detected is likely to be affected by many of the same factors that influence screening practices in the general population [10–30], but it is also likely to be influenced by the biologic characteristics of the tumor [45, 46], which may be affected by breast cancer risk factors [46–49].

For women in the US under age 50, there have been few studies [41–44] of patterns of breast cancer detection, and no study of factors that predict methods of detection. This may be in part due to the lack of scientific consensus on the overall benefit of screening women under age 50, differences among organizations in screening recommendations, and changes in recommendations over time [1–7, 10, 50–59]. Since the late 1980s, some organizations have consistently recommended breast cancer screening of women age 40–49 [2, 4–6], but others have not [1, 59], and the US National Cancer Institute and the US Department of Health and Human Services, in its national "Healthy People" objectives, dropped and then reissued screening guidelines for women in their 40s [3, 5, 7, 50–54, 58]. Although consensus has not been reached on the balance of potential benefits and harms of screening among younger women, most organizations in the US that issue guidelines, now recommend mammography for women in their 40s, and many recommend CBE [2, 3, 50–57]. Information on the methods by which breast cancers in younger women are detected and on factors that may influence how cancers are detected is important due to their potential impact on breast cancer mortality.

The purposes of this study were to describe the methods of breast cancer detection among women age 20–44 diagnosed during 1990–1992, in three different areas of the US, to describe the relationships between methods of detection and breast cancer stage, and to identify factors that predicted whether the cancers were detected by routine mammography or by CBE rather than being self-detected. During 1990–1992, most organizations in the US that issued breast cancer screening guidelines recommended mammography for women age 40–49, and some organizations recommended at least baseline mammograms for younger women [4, 6]. CBE was commonly recommended for women in their 40s, and some recommended it for women in their 20s and 30s [4, 6]. Because the efficacy of breast self-exam (BSE) has not been established [1], because recent research indicates it may be ineffective [60–62], and because it is less frequently recommended as a screening method than mammography and CBE [3], we described the prevalence of detection by BSE and its relation with stage, but did not examine determinants of detection by BSE. Since survey data suggest that between 1991 and 1997 there was little change in mammography utilization among women age 40–49 [13], the patterns of breast cancer detection during this study period may not be very different from patterns in the late 1990s.

Methods

We used data obtained from a population-based case–control study conducted in the metropolitan areas of Atlanta, Georgia, and Seattle, Washington, and in five counties in central New Jersey [63]. The protocol was approved by institutional review boards at each collaborating institution. All women age 20–44 years newly diagnosed with breast cancer from 1 May 1990 through 31 December 1992, in the designated counties, were identified through rapid review of hospital medical records. Women with a prior diagnosis of breast cancer were ineligible. Of 1940 eligible cases, in-person interviews were completed on 1668 (86.0%). Non-interviews were due to subject refusal (6.7%), physician refusal (5.8%), death or illness (0.8%), and other reasons (0.7%). Eighty percent were interviewed within 6 months of diagnosis.

Information on method of detection was obtained from the interview question, "Who first noticed the problem which led to the discovery of your breast cancer?" Response categories printed on a card handed to respondents included "routine mammography," which we retained as a separate classification, and "routine physical exam by a doctor," which we have labeled CBE. We combined as self-detected those which were symptomatic, including those discovered by "accidental self-discovery" and "accidental discovery by a partner." For the multivariate analyses we grouped those discovered by "routine self-examination" with "self-detected." For cancers that were found "in some other way," follow-up questions obtained more specific information. Those cancers that involved symptoms such as pain or discharge were added to the self-detected category. We included in the CBE category the 1% of cancers that were detected by a physician when women were seen for other medical problems, since the prevalence of late-stage disease was similar in the two groups and because physicians are recommended to provide preventive services such as CBE during office visits for other health problems, and many do so [64].

Information was available from the study on a variety of factors found in the literature to predict screening utilization [10–30] or method of detection [43]. Year of diagnosis and geographic location indicated potential regional or time-related differences in screening utilization [11, 43]. Demographic characteristics [14–24] included age at diagnosis, ethnicity, marital status, and religion. For ethnicity, because of small numbers of nonwhites and similarities in distributions of methods of detection, we combined 38 white Hispanics with 1242 non-Hispanic white women, and 253 black women with 86 women of other ethnicities (including 61 Asian and seven Native American). Education, usual occupation, household income, and the number of people supported by the income were available as measures of socioeconomic circumstances [14, 15, 21–27]. Occupation was categorized into three groups: professional/managerial (standard US census occupational codes [65] 0–3600), clerical and service (3601–5264), and blue-collar (5265–8761). Few women did not have a usual occupation and the methods of detection were similar to those for blue-collar occupations, so the two were grouped. We created a poverty index by dividing the household income by the poverty-level income given the number of people supported [66]. Health status measures [30] included personal history of cancer other than breast cancer and a comorbidity variable, coded positive if the respondent had ever been told by a physician she had hypertension, high cholesterol, or diabetes. Although information on the women's health insurance status, usual source of care, and physician's specialty and screening recommendations [14, 17, 19] was not available, we had relevant measures of health services utilization [14, 17–19, 21]: the number of mammograms and the frequency of CBE in the 5 years prior to a year before interview. As measures of preventive behavior [29] we included history of breast self-exam, usual adult physical activity, alcohol consumption, and smoking status. In addition, we had information on other breast cancer risk factors [11, 14, 17, 21, 30]: age at menarche, menopausal status, number of term births, age at first term birth, history of breast biopsy, family history of breast cancer, duration of oral contraceptive and hormone replacement use, and breast size (bra cup size). From measured height and weight we calculated a body mass index (BMI) [weight (kg)/height $(m)^2$]. Exposure to all factors was truncated at date of diagnosis.

The stage of the cancer at diagnosis was obtained for patients in Seattle and Atlanta from the Surveillance, Epidemiology, and End Results (SEER) program [67] cancer registry records. In New Jersey, stage was obtained from patients' medical records. Stage was defined as *in situ* if the neoplasm was non-infiltrating, localized if the invasive neoplasm was confined entirely to the breast, regional if the tumor had extended directly beyond the breast into surrounding tissues or into regional lymph nodes, or distant if it had spread to sites remote from the primary tumor by direct extension or by discontinuous metastases.

We excluded 17 cases for whom no information was available on method of diagnosis and 32 for whom stage was missing. For the final analyses, we excluded an additional 56 women for whom data on predictors and confounders were unavailable.

We used logistic regression [67, 68] to examine associations between method of detection and the potential predictors listed above. CBE detection and mammography detection were modeled separately, with self-detection as the "control" category for both. All models were adjusted for race, geographic location, and year and age of diagnosis. Tumor stage was the only biological characteristic available for most cases, and we included it as a surrogate for differences in tumor biology, as did the only other published study on predictors of methods of breast cancer detection [43]. However, since routine screening detects some breast cancers at an earlier stage in the progression, while other more aggressive cancers spread despite screening [47, 70], stage is an outcome as well as a determinant of method of detection. Therefore, we examined associations for both adjusted and unadjusted. Because a large number of factors were plausible determinants of method of detection, but few had been previously examined and those only in one study [43], we used a modeling approach that excluded factors that appeared to be unimportant but retained both predictors, *i.e.* those factors that were strongly associated with method of detection, and potential confounders, *i.e.* those factors that less clearly associated with the outcomes but were plausible determinants. We first excluded the factors that were not statistically significant at $p \leq 0.25$ [68, 71], adjusted for age and year of diagnosis, location, and ethnicity. This procedure identified the same set of factors we obtained by using either forward or backward variable selection procedures [68, 69] ($p \leq 0.25$), and included all factors that appeared from the crude odds ratios to be associated with method of detection by trend or by strength of association. From models with this limited set of factors, we excluded those factors that were unrelated to the outcomes when adjusted for the other factors in this model. We then re-evaluated the excluded factors as either predictors or confounders by re-introducing them into the smaller model. For variables with ordered categories, trend tests were obtained by entering the measures as ordinal variables. To determine if the relations between any of the determinants and method of detection varied by category or level of other predictors, we assessed the significance of interaction terms and did stratified analyses.

Results

Approximately 71% of the breast cancers were self-detected, 9% detected by CBE, and 20% detected during a routine mammogram (Table 1). Excluding *in-situ* cancers, the percentages for self-detection, CBE, and mammography detection were 77%, 9%, and 14% (data not shown).

More than a third of the cancers were late stage (regional or distant) at diagnosis, and method of detection was strongly related to stage (Table 1). Fifteen percent of mammography-detected cancers were late stage, whereas approximately 33% and 45% of CBE and self-detected cancers, respectively, were late stage. The stage distribution of the BSE-detected cancers was similar to that for the accidental self-detected cancers, about 45% late stage. Excluding *in-situ* cancers, the percentage of the breast cancers that were late stage were 25% for mammography (47/191), 39% for CBE, and 47% for self-detected.

Just over half of the women in the study were in their 40s, and the majority were white, married, and born in the US (Table 2). Half had at least some college education, almost two-thirds worked in white-collar or service occupations, and most were well above the poverty level in income and had no major comorbidity. Almost half had not had a mammogram in the previous 5 years, although more had a history of CBE and most practiced some BSE during the same period.

Method of detection was strongly related to age at diagnosis, with more than 90% of cancers among women age 20–29 being self-detected and less than 65% of cancers in women age 40–45 being self-detected (Table 2). For cancers detected by mammogram the trend in relation to age was the opposite: from 2% among women age 20–29 to 25% in women age 40–44. CBE detection was somewhat lower among women age 20–29 than among older women. Among women in their 40s, the percentages self-, CBE-, and mammography-detected were 65%, 10%, and 25%, and excluding *in-situ* cases they were 72%, 10%, and 19%, respectively (data not shown).

In initial analyses, many of the factors we examined were at least suggestively related to detection by either CBE or mammography ($p < 0.25$, adjusted for age, location, and ethnicity) (Table 2). Self-detected cancers appeared to be less common in white women, among certain religious groups, among women born in the US, and among women of higher socioeconomic status. Self-detected cancers were somewhat more common in women living in larger households and, perhaps, women with comorbid conditions. Women with prior histories of mammography and CBE were less likely to have had self-detected cancers, but the opposite was true of women who routinely practiced BSE. Premenopausal women, women who had few or no term births, and those who gave birth to children at later ages were less likely to have had self-detected cancers. Women with a family history of cancer were also less likely to have self-

Table 1. The relation between method of breast cancer detection and stage, among women age 20–44 newly diagnosed in Atlanta, Seattle, and central New Jersey (US), 1990–1992

Method of detection[a]	Stage								Total	
	In-situ		Local		Regional		Distant		No.	Percentage[c]
	No.	Percentage[b]	No.	Percentage[b]	No.	Percentage[b]	No.	Percentage[b]		
Mammography	126	39.8	144	45.4	47	14.8	0	0.0	317	19.6
CBE, all	23	15.3	77	51.3	48	32.0	2	1.3	150	9.3
CBE, routine	20	14.9	69	51.5	44	32.8	1	0.8	134	8.3
CBE, other	3	18.8	8	50.0	4	25.0	1	6.3	16	1.0
Self, all	65	5.6	574	49.8	483	41.9	30	2.6	1152	71.2
Self, routine BSE	34	6.1	276	49.7	235	42.3	10	1.8	555	34.3
Self, accidental	19	4.0	243	51.3	195	41.1	17	3.6	474	29.3
Self, partner	1	2.0	28	54.9	22	43.1	0	0.0	51	3.2
Self, symptoms	11	15.3	27	37.5	31	43.1	3	4.2	72	4.5
Total	214	13.2	795	49.1	578	35.7	32	2.0	1619	100

[a] Mammography: routine mammography; CBE, routine: routine physical exam by a doctor; CBE, other: detected by a physician when women seen for another problem; Self, routine BSE: routine self-discovery; Self, accidental: accidental self-discovery; Self, partner: accidental discovery by a partner; Self, symptoms: symptoms such as pain or discharge.

[b] Row percentages.

[c] Column percentages.

Table 2. Description of the study population and patterns of method of breast cancer detection by selected characteristics, among women age 20–44 newly diagnosed in Atlanta, Seattle, and central New Jersey (United States) during 1990–1992

Characteristic[a]	No.	Percentage	Method of detection[b] (%)		
			Self	CBE	Mamm.
Age at diagnosis (years)					
20–29	58	3.6	91.4	6.9	1.7
30–34	208	12.9	84.1	10.6	5.3
35–39	479	29.6	74.1	8.4	17.5
40–44	874	54.0	65.1	9.6	25.3
Ethnicity					
White	1280	79.1	68.8	9.7	21.5
Nonwhite	339	20.9	79.9	7.7	12.4
Marital status					
Married	1111	68.6	70.9	8.8	20.3
Widowed/Div.	332	20.5	73.2	10.2	16.6
Single	176	10.9	68.8	10.2	21.0
Religion					
Protestant	944	58.3	73.4	8.6	18.0
Jewish	91	5.6	63.7	15.4	20.9
Catholic	480	29.7	68.3	9.6	22.1
Other	43	2.7	67.4	14.0	18.6
None	61	3.8	72.1	4.9	23.0
Country of birth					
US	1483	91.7	70.3	9.5	20.2
Non-US	135	8.3	81.5	5.9	12.6
Occupation					
Blue-collar	130	8.0	80.0	3.1	16.9
Clerical/service	894	55.2	71.8	9.0	19.2
Prof/Mgr	595	36.8	68.2	11.1	20.7
Education					
≤High school	428	26.4	72.9	8.6	18.5
Voc/technical	110	6.8	80.0	7.3	12.7
Some college	424	26.2	72.9	7.1	20.1
College	407	25.1	67.3	11.3	21.4
Postgraduate	250	15.4	67.6	11.6	20.8
Poverty index					
≤200	230	14.5	83.0	6.1	10.9
201–350	356	22.5	69.9	12.6	17.4
351–500	342	21.6	71.9	7.6	20.5
501–700	307	19.4	67.1	8.1	24.8
> 700	351	22.1	67.0	10.5	22.5
Number of people supported by household income					
1	233	14.7	68.2	9.4	22.3
2	354	22.3	67.5	12.2	20.3
3	312	19.7	71.8	9.6	18.6
4	460	29.0	72.0	8.5	19.6
≥5	227	14.3	76.7	5.7	17.6
Personal history					
No	1571	97.0	71.1	9.4	19.5
Yes	48	3.0	72.9	6.3	20.8
Comorbidity					
No	1130	69.8	70.4	10.0	19.6
Yes	489	30.2	72.8	7.6	19.6

Table 2. (Continued)

Characteristic[a]	No.	Percentage	Method of detection[b] (%)		
			Self	CBE	Mamm.
Mammograms in past 5 years[c]					
None	763	47.1	79.0	7.5	13.5
1	361	22.3	70.9	8.3	20.8
2	213	13.2	61.0	13.2	25.8
≥3	282	17.4	57.8	12.4	29.8
CBE in past 5 years[c]					
Never	554	34.2	74.2	9.4	16.4
1/year	907	56.0	70.0	8.4	21.6
≥1/year	158	9.8	67.1	13.9	19.0
BSE in past 5 years[c]					
Never	376	23.2	63.8	16.2	20.0
< 12/year	548	33.9	70.3	9.1	20.6
≥12/year	695	42.9	75.8	5.6	18.6
Menopausal status					
Premenopausal	1433	89.7	70.4	9.4	20.2
Postmenopausal	164	10.3	75.6	9.2	15.2
Number of term births					
None	407	25.1	66.6	10.8	22.6
1	331	20.4	68.0	11.8	20.2
2	578	35.7	72.5	8.8	18.7
3	219	13.5	74.9	5.5	19.6
≥4	84	5.2	86.9	4.8	8.3
Age at first term birth (years)					
< 20	219	13.5	77.6	10.1	12.3
21–24	367	22.7	74.1	8.5	17.4
25–29	344	21.3	72.4	7.3	20.4
≥30	281	17.4	67.6	9.6	22.8
None	407	25.2	66.6	10.8	22.6
Family breast cancer history					
None	1233	76.2	72.9	8.7	18.4
Grandmother, half-sister	156	9.6	68.0	11.5	20.5
Mother, sister	230	14.2	63.9	10.9	25.2

[a] Characteristics associated with method of detection at $p \leq 0.25$, adjusted for year and age of diagnosis (continuous), location, and ethnicity. Widowed/Div: widowed, divorced, separated; Voc./technical: vocational or technical; Prof/Mgr: professional/managerial.

[b] Mamm: routine mammography; CBE: routine physical exam by a doctor or detected by a physician when women seen for another problem; Self: routine self-discovery, accidental self-discovery, accidental discovery by a partner, or symptoms such as pain or discharge.

[c] History in the 5 years prior to a year before interview.

detected cancers. The other factors we examined, including BMI and breast size, were not associated with method of detection (data not shown).

Fewer characteristics remained important determinants of detection by CBE when adjusted for other factors (Table 3). CBE detection was more common than self-detection among women with the following characteristics: working in higher-status occupations,

Table 3. Predictors of breast cancer detection by CBE rather than by self-detection, adjusted for other determinants, with and without adjustment for tumor stage, among women age 20–44 newly diagnosed in Atlanta, Seattle, and central New Jersey (US), 1990–1992

Predictors	Unadjusted for stage[a]			Adjusted for stage[a]		
	OR[b]	95% CI[b]	*p*[c]	OR	95% CI	*p*
Age at diagnosis (years)						
20–29	1.0			1.0		
30–34	1.70	0.53–5.5		1.91	0.58–6.3	
35–39	1.57	0.50–4.9		1.80	0.56–5.8	
40–44	1.53	0.49–4.8	0.66	1.73	0.54–5.5	0.60
Religion						
Protestant	1.0			1.0		
Jewish	1.96	0.94–4.1	0.08	1.93	0.92–4.1	0.07
Catholic	1.26	0.81–2.0	0.31	1.28	0.81–2.0	0.28
Other	2.97	1.0–8.7	0.07	2.92	0.99–8.6	0.07
None	0.69	0.19–2.4	0.59	0.66	0.19–2.4	0.55
Place of birth						
US	1.0			1.0		
Non-US	0.40	0.17–0.97	0.04	0.41	0.17–0.99	0.04
Occupation						
Blue-collar	1.0			1.0		
Clerical/Serv.[d]	3.16	1.1–9.2		3.20	1.1–9.3	
Prof/Mgr[d]	4.09	1.4–12.4	0.03	4.22	1.4–12.8	0.02
No. of people supported by household income						
1	1.0			1.0		
2	1.48	0.80–2.7		1.50	0.82–2.8	
3	1.10	0.53–2.3		1.07	0.51–2.2	
4	0.88	0.43–1.8		0.89	0.43–1.9	
≥5	0.59	0.25–1.4	0.01	0.58	0.24–1.4	0.01
Comorbidity						
No	1.0			1.0		
Yes	0.63	0.41–1.0	0.04	0.61	0.39–0.94	0.04
Mammograms in past 5 years[e]						
None	1.0			1.0		
1	1.32	0.80–2.2		1.27	0.77–2.1	
2	2.76	1.6–4.9		2.61	1.5–4.7	
≥3	3.16	1.8–5.5	0.00	2.92	1.7–6.0	0.00
BSE in past 5 years[e]						
None	1.0			1.0		
< 12/year	0.35	0.22–0.56		0.36	0.23–0.57	
≥12/year	0.22	0.13–0.35	0.00	0.23	0.14–0.36	0.00
Stage						
In-situ	n.a.			1.0		
Local				0.42	0.23–0.76	
Regional/distant				0.36	0.19–0.67	0.01

[a] Odds ratios in the left column are adjusted for year of diagnosis, geographic location, ethnicity, menstrual status, age of first full term birth, and other factors in the table, except for stage. Odds ratios in the right column are adjusted for the same set of factors and, in addition, for stage.
[b] OR: odds ratio, 95% CI: 95% confidence interval.
[c] For ordered variables, trend test *p*-values are presented.
[d] Clerical/serv. = clerical and service; Prof/Mgr = professional and managerial.
[e] History in the 5 years prior to a year before interview.

without a chronic disease history, with a history of mammography utilization, and not practicing BSE. CBE detection also appeared to be more common than self-detection among women who were age 30 and older, Jewish or of "other" religious affiliation (including Muslim, Hindu, Greek Orthodox, etc.), born in the US, or living in a two-person household, but confidence intervals around the odds ratios were wide, consistent with no true association. Although stage was related to CBE detection, adjustment for stage had little or no effect on relations between other factors and CBE detection. Relations between predictors and detection by CBE did not appear to vary by age group or by category of other predictors, although we had small numbers and limited power to address these issues.

Detection by mammography was related to a somewhat different set of factors (Table 4). Adjusted for other predictors, the odds that the breast cancers were identified by routine mammography rather than by self-detection increased strongly with age, from 1.0 among women age 20–29 to 20 among women age 40–44. The odds that the breast cancers were identified by mammography rather than by self-detection were also increased among women who had a history of prior mammography use, women who did not practice BSE, and women who were premenopausal. There appeared to be positive relationships with birth in the US, a higher poverty index, living in a smaller household, family history of breast cancer, and a later age at first term birth, but confidence intervals were wide and included odds ratios of 1.0. While stage was strongly related to detection by CBE (Tables 1 and 3), it was more strongly related to detection by mammography (Tables 1 and 4) and, perhaps as a result, adjustment for stage reduced associations between detection by mammography and five of the factors we examined, including age, poverty index, number of people supported, and both mammography and BSE screening histories. This suggested that, when differences in tumor biology were taken into consideration, true odds ratios associating these factors with mammography detection were likely to lie between the stage-adjusted and stage-unadjusted odds ratios. Relations between predictors and detection by mammography did not vary by age group or by category of other predictors.

Discussion

This study provides the first population-based data on methods of detection of breast cancer in young women living in more than one geographic area of the US (Table 5). Among women age 20–44 during 1990–1992, 71% of all cancers were self-detected and only 20% were detected by mammography. For women age 40–44, only 25% of all breast cancers and 19% of invasive cancers were detected by mammography. These numbers are consistent with the only other population-based study in the US, that in Wisconsin by Reeves and colleagues who found that during 1988–1990 among women age 40–49, 22% of invasive breast cancers were detected by routine mammography [43]. We found little regional variation in patterns of detection, with 18%, 21%, and 19% of all cancers mammography-detected, in Atlanta, Seattle, and New Jersey, respectively.

The prevalence of mammographic screening among US women age 40–49 increased substantially from the 1970s to the early 1990s [10–13], and there is likely to have been a corresponding increase in the proportion of cancers detected by mammography, although there is limited information available on this issue (Table 5). Among women 40–49, in the late 1970s only 15–20% were likely to have ever had a mammogram [10], but in 1990, 30% reported in the National Health Interview Survey having had a mammogram during the previous year [12], and in 1990–1992, 60–64% reported in the Behavioral Risk Factor Surveillance System survey having had a mammogram in the previous 2 years [13]. Data on methods of detection among cancer patients are not routinely collected in cancer surveillance systems, and there are few studies, most of which are not population-based (Table 5). The studies suggest that between the 1970s and the early 1990s there may have been an increase in the detection by mammography and reduction in self-detection, as anticipated. The percentages of breast cancers detected by screening in studies of patients are lower than the percentages of women who report routine screening due to a number of factors, potentially including over-reporting of screening use in general population surveys [72], the failure of screening tests to detect all tumors, particularly in younger women [1, 8, 9, 50, 51], and the possibly reduced effectiveness of screening in community practice in comparison with clinical trials [40].

Our findings regarding the relationship between method of detection and stage of disease at diagnosis are generally consistent with the limited literature [39, 41–44]. Mammography-detected tumors are more likely to be smaller and lymph node-negative, and self-detected tumors larger and node-positive, with CBE-detected tumors being intermediate in size and percentage node-positive. Only one study [44] presented data separating BSE-detected cancers from other self-detected cancers, and it found no significant differences in size or lymph node involvement between the two types of self-detected cancers.

Our findings with regard to potential determinants of method of detection in young women provide unique new information. The other study on this issue [43] examined methods of detection in women age 20–70. Two of our findings, that of age and mammographic screening history, were positively associated with increased odds of having the cancer detected by routine mammography. Our findings that family history was suggestively related to increased detection by

Table 4. Predictors of breast cancer detection by mammography rather than by self-detection, adjusted for other determinants, with and without adjustment for tumor stage, among women age 20–44 newly diagnosed in Atlanta, Seattle, and central New Jersey (US), 1990–1992

Predictors	Unadjusted for stage[a]			Adjusted for stage[a]		
	OR[b]	95% CI[b]	*p*[c]	OR	95% CI	*p*
Age at diagnosis (year)						
20–29	1.0			1.0		
30–34	3.58	0.44–28.8		4.65	0.53–40.5	
35–39	13.2	1.8–98.6		18.0	2.2–145.2	
40–44	19.9	2.7–148.6	0.00	28.0	3.5–225.3	0.00
Ethnicity						
White	1.0			1.0		
Non-white	0.73	0.48–1.1	0.13	0.67	0.42–1.1	0.16
Country of birth						
US	1.0			1.0		
Non-US	0.58	0.32–1.1	0.11	0.51	0.27–0.99	0.05
Poverty index						
≤200	1.0			1.0		
201–350	1.51	0.86–2.6		1.25	0.68–2.3	
351–500	1.52	0.87–2.7		1.12	0.61–2.0	
501–700	1.86	1.1–3.3		1.52	0.82–2.8	
> 700	1.53	0.86–2.7	0.32	1.27	0.68–2.4	0.48
No. of people supported by household income						
1	1.0			1.0		
2	0.81	0.47–1.4		1.02	0.55–1.9	
3	0.55	0.28–1.1		0.62	0.29–1.3	
4	0.52	0.25–1.1		0.60	0.27–1.3	
≥5	0.47	0.22–1.0	0.14	0.58	0.25–1.4	0.50
Family breast cancer history						
None	1.0			1.0		
Grandmother, half-sister	1.18	0.75–1.9		1.33	0.81–2.2	
Mother, sister	1.31	0.90–1.9	0.12	1.27	0.83–2.0	0.15
Mammograms in past 5 years[d]						
None	1.0			1.0		
1	1.32	0.92–1.9		1.11	0.75–1.7	
2	1.70	1.1–2.6		1.43	0.90–2.3	
≥3	1.98	1.3–2.9	0.01	1.43	0.93–2.2	0.22
BSE in past 5 years[d]						
None	1.0			1.0		
< 12/year	0.67	0.46–0.97		0.78	0.52–1.2	
≥ 12/year	0.59	0.41–0.84	0.01	0.69	0.46–1.0	0.06
Menopausal status						
Premenopausal	1.0			1.0		
Postmenopausal	0.51	0.31–0.82	0.01	0.56	0.33–0.96	0.02
Age at first term birth (years)						
< 20	1.0			1.0		
20–24	1.40	0.82–2.39		1.69	0.94–3.1	
25–29	1.52	0.88–2.63		1.78	0.97–3.3	
≥30	1.57	0.89–2.71		1.93	1.0–3.6	
Never	1.30	0.73–2.31	0.20	1.39	0.73–2.6	0.13
Stage						
In-situ	n.a.			1.0		
Local				0.12	0.08–0.18	
Regional/Distant				0.05	0.03–0.08	0.00

[a] Odds ratios in the left column are adjusted for year of diagnosis, geographic location, religion, marital status, and other factors in the table, except stage. Odds ratios in the right column are adjusted for the same set of factors and, in addition, stage.
[b] OR: odds ratio; 95% CI: 95% confidence interval.
[c] For ordered variables, trend test *p*-values are presented.
¶ History in the 5 years prior to a year before interview.

Table 5. Patterns of breast cancer detection in young women

Location/sample (size)	Years of diagnosis	Ages of cases (years)	Excludes *in-situ* cancers	Self-detected (%)	Routine CBE[a] (%)	Routine mammography (%)	Reference
New York City/one hospital (188)	1976–1978	40–49	No	88	11	1	Senie *et al*., 1994 [41]
US/582 selected hospitals (1570)	1977	< 45	No	80	17	3	Nemoto *et al*., 1982 [42]
Wisconsin/state-wide (555)	1988–1990	40–49	Yes	71	7	22	Reeves *et al*., 1995 [43]
US/28 selected Midwest hospitals (971)	1986–1992	40–49	Yes	58	12	30	McPherson *et al*., 1997 [44]
US/Atlanta, Seattle, New Jersey (1619)	1990–1992	< 45	No	71	9	20	Current study
US/Atlanta, Seattle, New Jersey (1405)	1990–1992	< 45	Yes	77	9	14	Current study
US/Atlanta, Seattle, New Jersey (874)	1990–1992	40–44	No	65	10	25	Current study
US/Atlanta, Seattle, New Jersey (741)	1990–1992	40–44	Yes	72	10	19	Current study

[a] Clinical breast exam.

mammography and that CBE detection was reduced in the youngest women are also consistent. However, Reeves *et al*. [43] found that the odds of having a mammogram-detected cancer increased with education, BMI, and being postmenopausal. They also found that postmenopausal women were more likely to have CBE-detected cancers, that family history was associated with reduced likelihood of CBE detection among older women but increased likelihood of CBE detection among younger women, and that, among women with no family history of cancer, age was associated positively with CBE detection. Some of the differences in findings between the studies may be due to differences in the age of the study subjects. In addition, there were a number of methodologic differences between the studies that may have contributed to differences in findings, including differences in predictors measured and analyzed, in methods of analysis, and the inclusion of *in-situ* cancers. We included *in-situ* cancers because more than half of *in-situ* cancers may be followed by invasive disease unless they are treated [73].

Because effectiveness of mammography and of CBE may be influenced by factors that influence breast densities and other biologic characteristics of the breast and of the tumors [46–49, 74], determinants of method of detection may differ from determinants of screening behavior in the general population. However, many of our findings were consistent with the literature on determinants of breast cancer screening. The relation between age and screening appears to depend on the age distribution of subjects, most commonly increasing among women in their 30s and 40s, as we observed, and decreasing among women over age 60 or 70 [11, 14, 15, 19–24]. Routine mammographic screening has not been commonly recommended for women under age 40, and CBE may be less commonly provided to women in their 20s, because of the low cancer risk. Health-care utilization varies by religion [75] and at least one study [76] has reported variations in mammographic screening by religion. Health-care access has been hypothesized to be responsible for at least some of the differences in screening by race and ethnicity [77], and early surveys found black women less likely than white women to have been screened [14], although surveys in the 1990s have found little or no difference [12, 13, 15]. Other ethnic minorities may be less likely to be screened [12, 13, 15]. Reduced health services access or knowledge may contribute to differences in screening utilization by occupation, income, and education, but those socioeconomic factors are not always consistently related to screening use [12, 14, 16, 18, 19, 22, 23, 25, 26, 30]. Variations in screening practices by household size are thought to reflect balances between social support and the need for women to devote time and attention to other family members, and women in two-person households may be most likely to obtain screening [28]. The presence of other chronic conditions has been associated with reduced screening as those conditions may take priority over breast cancer detection and because of effects of life expectancy on decisions to screen [27, 30]. Although a family history of breast cancer might provide increased reason to screen, and Reeves *et al*. [43] found family history predictive of detection by mammography among younger, but not older, women with breast cancer, family history has been inconsistently related to utilization of mammographic screening in the general population [14, 18, 20, 24, 29, 30]. Previous mammography and CBE screening practices are predictors of current screening practices [14, 18, 27]. In at least one study [19], BSE practice has been found to be a predictor of mammographic screening in the general population, and in our study BSE history was positively, though not strongly, associated with histories of both mammography and CBE (data not shown). However, we found that BSE history was inversely related to detection by either CBE or mammography. This same inverse relation was described in a paper which examined methods of breast cancer detection among patients [41], but the study provided no information on statistical significance and there was no control for possible confounding. Reasons for an inverse relation are not clear. One might anticipate that premenopausal women are less likely than postmenopausal women to have mammogram-detected cancers because greater breast density in premenopausal women reduces sensitivity of the test [78]. Our finding of the opposite relationship is based on a small number of postmenopausal women, all under age 45, less than 1% of whom were naturally postmenopausal and a third of whom used hormone replacement. The relation we observed may not be generalizable to most postmenopausal women.

This study is the first on patterns and predictors of method of breast cancer detection in young women and only the second of which we are aware to examine predictors among women of any age. For an examination of this topic, this study was subject to several limitations and had several strengths. Although the study was not representative of the US as a whole, it was population-based and included women in three different parts of the country, contributing to its generalizability. Our study may have overestimated somewhat the proportion of cancers that were screen-detected because detection is related to stage and survival and, therefore, to the likelihood that cases were interviewed. However, the interview response rate was high, and few women were not interviewed specifically due to illness or death. Information on method of detection was recalled sometimes several months after diagnosis and the sequence of events leading to diagnosis may not always have been accurately recalled. In addition, since women who undergo mammography in the US commonly have a CBE, it may be somewhat difficult to attribute the initial detection to only one of those two screening methods. However, cards were offered as a visual aid during interviews, and ambiguous responses were followed up with probing questions to more clearly establish how detection occurred. The study included a large number of young women, but because the proportions of cancers detected by CBE and mammography were small, we had limited power to examine relations between predictors and methods of detection among subgroups. Although we lacked information on some health systems factors, knowledge and attitudes toward screening, and measures of tumor biology other than tumor stage, we had relevant information on prior breast screening practices, on other health behaviors, and on breast cancer risk factors, which reduced the chance that the study failed to examine important predictors or include proper adjustment for confounding.

Our findings suggest that, during 1990–1992, among women age 20–44, most breast cancers were self-detected. Although mammography was commonly recommended for women in their 40s, and a majority of US women in their 40s reported receiving mammographic screening during the previous 2 years, only a fifth of the breast cancers among women 40–44 may have been identified by mammography, with another tenth identified by CBE. Because self-reported mammography appears to have increased very little during 1991–1997, these percentages for women in their early 40s may apply to the late 1990s. Detection by mammography or by CBE resulted in an earlier stage at diagnosis than did self-detection, but detection by BSE did not result in earlier stage than did accidental self-detection. Among these women, those in their 40s were much more likely than younger women to have their cancers detected by mammography, and those with a history of mammography use were more likely to have breast cancers detected by either mammography or by CBE. These results add to the quite limited information available on how breast cancers are detected in the general population, and about factors that may influence how those cancers are detected.

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