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ORIGINAL PAPER

Breast cancer screening among low-income or uninsured women: results from the National Breast and Cervical Cancer Early Detection Pogram, July 1995 to March 2002 (United States)

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Abstract
Objective To describe the results of breast cancer screening among low-income and uninsured women in the only national organized screening program in the US, the National Breast and Cervical Cancer Early Detection Program (NBCCEDP).
Methods We analyzed mammography and diagnostic follow-up data for 789,647 women who received their first mammogram in the NBCCEDP and 454,754 subsequent mammograms among these women. We calculated the rate of mammograms with abnormal findings, diagnostic follow-up, biopsy, and cancers detected per 1000 mammograms by age and racial or ethnic groups. Positive Predictive Values (PPVs) were estimated for abnormal mammograms and biopsy.
Results Nearly 64% of the women screened in the program were from 50 to 64 years of age and about 46% were members of racial or ethnic minority groups. Women aged 40 to 49 years had the highest rates of abnormal mammograms and of diagnostic follow-up. However, cancer detection rates were highest in women aged 60 to 64 years. In addition, the PPVs for both abnormal mammograms and biopsy were highest in the oldest age group.
Conclusions Cancer detection rates and PPVs for both abnormal mammograms and biopsy were highest in women aged 50 years or more. These results support the program's focus on screening women aged 50 and older for breast cancer.

Keywords Breast cancer · Mammography · Screening

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Introduction

As the second leading cause of cancer-related deaths among women in the US, breast cancer is a major cause of morbidity and mortality. An estimated 215,990 new cases of invasive breast cancer and 40,580 deaths are expected to occur among US women in 2004 [1]. Based on a review of studies on breast cancer screening [2], the US Preventive Services Task Force currently recommends screening mammography, with or without a clinical breast examination, every one to two years for women aged 40 years or older [3]. The reduction in mortality associated with mammography screening is greatest in women aged 50 to 69 years. Based on data from the 2000 National Health Interview Survey, about 70% of women 40 years of age or older reported a mammogram in the previous two years. However, women with no usual source of care had lower reported screening rates (61%) [4] Despite the overall high rate of screening and the proven benefits of mammography in older women, women with a low-income or no health insurance and members of minority groups are less likely to utilize mammography screening services [4, 5].

Because having a low-income or no insurance is associated with decreased utilization of mammography screening, poor and uninsured women are an important priority population for

breast cancer screening programs. The Breast and Cervical Cancer Mortality Prevention Act of 1990 (Public Law 101-354) led to the creation of the National Breast and Cervical Cancer Early Detection Program (NBCCEDP) for this underserved population. The goal of the NBCCEDP is to increase access to breast and cervical cancer screening, diagnostic, and follow-up services among low-income and uninsured women in the US [6]. In 1991, programs were initiated in eight states with new programs beginning in each subsequent year. By 1997, the Centers for Disease Control and Prevention (CDC) supported breast and cervical cancer screening programs in 50 states, the District of Columbia, five US territories, and 13 American Indian and Alaska Native programs. CDC provides grants directly to each state or territorial health department or tribal organization. These organizations coordinate delivery of clinical services through a variety of institutions including local health departments, community health centers, and hospitals. Clinical services are provided within traditional clinical settings.

Overall and race- and ethnicity-specific breast and cervical cancer screening results have been published previously for earlier time periods [7–10]. In our report, breast cancer examination results are updated from the earlier reports to include data from July 1995 through March 2002 and are presented by race, ethnicity, and age. Data from the NBCCEDP provide a unique opportunity to assess mammography results from a large national population of traditionally underserved women.

Methods

We analyzed data collected as part of the breast cancer screening and diagnostic service provided by state, territorial, and tribal programs funded through the NBCCEDP. Data were available for history of a previous mammogram, reported breast symptoms, clinical breast examination results, mammogram results, whether or not diagnostic tests were performed, and final diagnosis. Pathology data for final diagnoses and staging are collected for the MDE dataset by local programs from a number of different sources and may not be the final pathology data used for cancer registry staging.

Self-reported information on race, ethnicity, and age were also available. If a woman reported that she was white, black, Asian-Pacific Islander, or American Indian/Alaska Native, she was classified as such. If she identified herself as Hispanic, we included her in the Hispanic category regardless of any other designations. We classified women who met none of those criteria as ''other.'' Results from mammograms were reported using the six categories (normal, benign, probably benign, suspicious abnormality, highly suggestive of malignancy, assessment incomplete) of the Breast Imaging Reporting and Data System (BI-RADS®) of the American College of Radiology [11]. We have only results from the mammogram and do not know if previous films were available for review before the assignment of the BI-RADS® code by the radiologist. Clinical breast examinations (CBE) are also part of breast cancer screening within the program. About 82% of screening cycles had a CBE recorded that preceded or occurred the same day as the mammogram. CBE results are categorized into three categories: normal/benign findings; abnormality suspicious for cancer; and not performed. The stage of diagnosis was reported using one of two systems: the American Joint Committee on Cancer (AJCC) system using stages one through four [12] or the Surveillance, Epidemiology and End Results Program (SEER) summary staging system with local, regional, and distant categories [13].

In this analysis, we included data for women aged 40 years or older who had their first NBCCEDP mammogram from July 1995 through March 2002. We utilized data on diagnostic procedures and final diagnosis reported to CDC through September 2002 to allow 6 months for diagnostic work-up to be completed and results to be entered after the initial mammogram. We included women who had incomplete follow-up in the denominator when calculating rates. Women with their first program mammogram in the selected time period were reported in the first round of screening regardless of whether or not they reported a previous mammogram elsewhere. Additional program mammograms received by these women were reported as subsequent rounds of screening. Results from subsequent mammograms were excluded for all women with a final diagnosis of invasive cancer or cancer *in situ* (n = 7374) identified during the first round of screening. We included all initial mammograms as screening mammograms including those in symptomatic women and women with a positive CBE result.

Abnormal mammograms were defined as those reported as BI-RADS® categories: suspicious abnormality (code 4), highly suggestive of malignancy (code 5), or assessment incomplete (code 0). Diagnostic follow-up was required by the program for all women with these mammogram results and for any women with an abnormal clinical breast exam (CBE). The rate of diagnostic follow-up was calculated per 1000 mammograms based on the number of mammogram records where at least one diagnostic test was recorded regardless of result of the mammogram. The biopsy rate was based on the number of needle or excisional biopsies per 1000 mammograms and does not include fine-needle cyst aspiration. Biopsies performed on women with normal mammogram results were included in the calculation of biopsy rates. The cancer detection rate was estimated per 1000 mammograms for invasive cancers, *in situ* cancers, and both combined. Because the age distributions of

women in the program vary among racial groups, cancer detection rates presented for racial groups were age-adjusted to the population of women receiving mammograms through the NBCCEDP in 2000 using the direct method [14]. Ninety-five percent confidence intervals for proportions were calculated based on the normal approximation to the binomial distribution. Although the focus of the NBCCEDP was on screening, women may have been referred into the program by an outside provider after they reported symptoms. To assess how referral into the program and mammograms conducted in symptomatic women might have affected the results from the program, we also calculated the follow-up, biopsy, and cancer detection rates per 1000 mammograms for the first round of mammograms while excluding women who reported breast symptoms.

We calculated all rates by four age groups (40–49, 50–59, 60–64, 65 or greater). Although women aged 65 and older were included in the NBCCEDP before 1998, most were not eligible for program services for much of the study period because their mammograms were eligible for payment through Medicare. The non-Medicare eligible women in this age group who were screened within the NBCCEDP were likely to have different characteristics than other women over age 64, and we included results from these women in a separate age category.

The positive predictive values (PPV) for detecting breast cancer for mammography and biopsies were estimated for each abnormal mammogram outcome and by age group. The PPV for abnormal mammograms was calculated as the percent of women with an abnormal mammogram result that had cancer. The PPV for abnormal mammogram results was estimated as the number of cancers (*in situ* or invasive) diagnosed per 100 abnormal mammograms. For biopsies, the PPV was estimated as the number of cancers diagnosed per 100 biopsies among women with an abnormal mammogram.

Results

During the time period July 1995 through March 2002, 818,654 women received their first mammogram within the NBCCEDP. After excluding women under age 40 (n = 28,965) or for whom age (n = 42) was missing, we were able to analyze mammography data for 789,647 women. After excluding the subsequent mammograms of any women following a diagnosis of breast cancer (n = 8343), data from 454,754 subsequent mammograms were available for analysis.

The majority (63.9%) of women receiving their first mammogram within the NBCCEDP were between the ages of 50 and 64 years (Table 1). The median age of the women in our analysis was 53.0 years. Slightly less than half of the women were from racial or ethnic minority groups, with Hispanic women constituting the largest proportion of minorities represented. Although we present data from the woman's first program mammogram, 63.7% of these women reported receiving a previous mammogram elsewhere. Among women receiving their first program mammogram, 11.0% reported breast-related symptoms. Abnormal clinical breast exams (CBE) were reported for 5.3% of women; however, 14.9% either did not have a CBE or did not have a result recorded (Table 2).

Table 1 Characteristics of women aged 40 years or more at the time of first mammogram provided by the National Breast and Cervical Cancer Early Detection Program (NBCCEDP), July 1995–March 2002

Characteristic	n	Percent
Age category (years)		
40–49	213,398	27.0
50–59	374,076	47.4
60–64	130,275	16.5
65 or greater	71,898	9.1
Race/ethnicity		
White, non-Hispanic	405,197	51.3
Black, non-Hispanic	133,843	17.0
Asian/Pacific Islander	33,995	4.3
American Indian/Alaska Native	39,080	5.0
Hispanic	157,561	20.0
Other/unknown	19,971	2.5
Self-report of previous mammogram		
Yes	503,122	63.7
No	180,869	22.9
Unknown/missing	105,656	13.4
Reported breast-related symptoms		
Yes	86,731	11.0
No	632,669	80.1
Unknown/missing	70,247	8.9
Total	789,647	

Overall, most women (65.1%) in this analysis had only one mammogram within the program, and 19.8% had only two mammograms during the time period July 1995 through March 2002. However, about 6.8% had four or more mammograms. Most mammogram results were negative (60.7%) or benign (21.9%) in the first round of screening (Table 2). The overall proportion of negative or benign mammogram results increased from 82.6% in the first screening round to 88.1% in the subsequent rounds. Women aged 40 to 49 years had the highest percent of abnormal mammograms and abnormal CBEs in both first and subsequent screening rounds.

Within the NBCCEDP population included in this analysis, the rate of abnormal mammograms, abnormal CBEs, diagnostic follow-up, and biopsy are all highest in women aged 40 to 49 years in both first and subsequent screening rounds (Table 3). Diagnostic follow-up rates reflect diagnostic tests associated with either a normal or abnormal mammogram and/or an abnormal CBE;

Table 2 Age-group specific breast cancer screening exam results in percent for first and subsequent screening rounds, NBCCEDP, July1995–March 2002

Results	40–49	50–59	60–64	65 or greater	Total
First round					
Number of women	213,398	374,076	130,275	71,898	789,647
Mammograms	%	%	%	%	%
Negative	61.0	59.9	59.7	65.9	60.7
Benign	18.8	22.8	24.3	22.1	21.9
Probably benign	7.0	6.2	6.0	5.0	6.3
Suspicious abnormality	2.5	1.7	1.6	1.3	1.9
Highly suggestive of malignancy	0.43	0.43	0.56	0.42	0.45
Assessment incomplete	10.4	9.1	7.9	5.3	8.9
Clinical breast exams					
Normal/benign	73.8	82.8	82.1	77.5	79.8
Abnormal suspicious for cancer	9.5	4.1	3.6	2.5	5.3
Not performed/unknown	16.7	13.1	14.3	20.0	14.9
Subsequent rounds					
Number of screenings	62,930	251,125	111,629	29,070	454,754
Mammograms	%	%	%	%	%
Negative	56.2	57.5	56.4	62.7	57.4
Benign	28.4	30.7	32.7	28.0	30.7
Probably benign	6.4	4.6	4.3	4.1	4.8
Suspicious abnormality	1.4	1.0	0.93	0.9	1.0
Highly suggestive of malignancy	0.12	0.10	0.14	0.12	0.12
Assessment incomplete	7.5	6.2	5.6	4.2	6.1
Clinical breast exams					
Normal/benign	72.7	82.6	82.9	80.5	81.2
Abnormal suspicious for cancer	5.7	2.8	2.4	2.0	3.0
Not performed/unknown	21.6	14.6	14.8	17.5	15.8

consequently diagnostic follow-up rates are higher than the rate of abnormal mammograms. For example, among women whose first program mammogram had a result of probably benign, 11.5% had additional mammographic views, 15.0% had an ultrasound, and 11.7% had a second CBE or surgical consult.

Cancer detection rates were similar in all age groups for the first round of screening except for women aged 60 to 64 years who had the highest rates for both *in situ* and invasive breast cancer. The rates of abnormal mammograms, diagnostic follow-up, and cancer detection associated with subsequent mammograms were lower than those in the first round of screening. During the study time period, invasive breast cancer was diagnosed in 5637 women during the first round of screening and 1160 women during subsequent rounds.

We also estimated the follow-up, biopsy, and cancer detection rates per 1000 mammograms for the first round of screening for women who did not report symptoms (Table 4). These estimates reflect results expected from asymptomatic women being screened with mammography. This analysis included 702,916 women having their first mammogram in the program without symptoms. The rate of diagnostic follow-up and biopsy were higher among women aged 40 to 49 years than in the other age groups. When women reporting symptoms were removed from the analysis, cancer detection rates were lowest in the youngest age group and increased with increasing age except in women aged 65 years and older.

Overall, Hispanic women had the highest rate of abnormal mammograms per 1000 (118.2; 95% CI: 116.4, 120.0) for the time period but relatively low cancer detection rates (Table 5). In the first round of screening, the highest age-adjusted invasive cancer detection rates were found among white, non-Hispanic women (9.0; 95% CI: 8.7, 9.4), followed by Black, non-Hispanic women (7.2; 95% CI: 6.7, 7.7).

The estimated PPV of an abnormal mammogram for detecting cancer (invasive or *in situ*) in the first round of screening was 7.9% (95% CI: 7.7, 8.1) (Table 6). The percent of women with an abnormal mammogram that were diagnosed with cancer (PPV) increased with increasing age and was highest in women ages 65 and older. As shown in (Table 6, the PPV varied widely by the mammogram results. For mammograms highly suggestive of malignancy, the percent of women diagnosed with cancer for all age groups combined was 74.9% in the first round of screening. Mammograms reported as assessment incomplete had the lowest

Table 3 Age-group specific rates of abnormal mammograms and biopsies per 1000 mammograms, and number and rate of cancers detected per 1000 mammograms for first and subsequent rounds of screening for all women, NBCCEDP, July 1995–March 2002

Results	Age groups				Total
	40–49	50–59	60–64	65 or greater	
First round					
Abnormal mammograms per 1000 mammograms[a]	132.5	111.9	100.8	70.1	111.8
Diagnostic follow-up per 1000 mammograms[b]	206.3	145.8	130.4	87.4	154.3
Biopsies per 1000 mammograms	40.0	29.7	29.1	19.2	31.4
Cancer detection					
Number of invasive cancers	1483	2545	1135	474	5637
Number of carcinomas *in situ*	423	799	362	153	1737
Invasive cancers per 1000 mammograms	6.9	6.8	8.7	6.6	7.1
Carcinoma *in situ* per 1000 mammograms	2.0	2.1	2.8	2.1	2.2
Subsequent rounds					
Abnormal mammograms per 1000 mammograms[a]	90.2	72.4	66.3	52.1	72.1
Diagnostic follow-up per 1000 mammograms[b]	158.9	107.8	96.8	76.6	110.2
Biopsies per 1000 mammograms	24.5	17.5	15.8	13.1	17.7
Cancer detection					
Number of invasive cancers	136	607	351	66	1160
Number of carcinomas *in situ*	66	302	144	45	557
Invasive cancers per 1000 mammograms	2.2	2.4	3.1	2.3	2.6
Carcinoma *in situ* per 1000 mammograms	1.0	1.2	1.3	1.5	1.2

[a] Abnormal mammograms were defined as BI-RADS® categories suspicious abnormality (code 4), highly suggestive of malignancy (code 5), or assessment incomplete (code 0)

[b] Diagnostic follow-up rates reflect diagnostic tests associated with either a normal or abnormal mammogram and/or an abnormal CBE

associated PPV. In subsequent screening rounds, the PPVs were lower than in the initial screening round; however, the patterns were similar with the overall PPV increasing with age and highest in those with a mammogram result of highly suggestive of malignancy.

The PPV of biopsy to detect breast cancer among women who had a biopsy following an abnormal mammogram for first and subsequent rounds of screening are provided in (Table 7, stratified by mammogram result and age. In the first round of screening, the overall percentage of cancer diagnosis following a biopsy was 29.3% (95% CI: 28.7, 30.0) after any abnormal mammogram. The patterns here were similar to PPVs for abnormal mammograms. The percent of women diagnosed with cancer after a biopsy increased with age and was highest in those with a mammogram highly suggestive of malignancy.

A total of 5637 invasive cancers and 1737 carcinomas *in situ* were diagnosed in the first round of screening; 1160 invasive cancers and 557 carcinomas *in situ* were diagnosed in the subsequent rounds. In the first round of screening 23.6% of cancers were *in situ* and 55.3% were

Table 4 Age-specific rates of abnormal mammograms and biopsies per 1000 mammograms, and number and rate of cancers detected per 1000 mammograms for the first round of screening in women without symptoms, NBCCEDP, July 1995–March 2002

Results	Age groups				Total
	40–49	50–59	60–64	65 or greater	
First round					
Mammograms (n)	176,232	338,745	120,119	67,820	702,916
Abnormal mammograms[a] per 1000 mammograms	113.1	103.5	93.9	67.2	100.8
Diagnostic follow-up per 1000 mammograms	155.1	126.8	115.4	80.4	127.5
Biopsies per 1000 mammograms	26.1	23.4	23.4	16.7	23.4
Cancer detection					
Number of invasive cancers	489	1254	653	340	2736
Number of carcinomas *in situ*	203	535	252	132	1122
Invasive cancers per 1000 mammograms	2.8	3.7	5.4	5.0	3.9
Carcinoma *in situ* per 1000 mammograms	1.2	1.6	2.1	1.9	1.6

[a] Abnormal mammograms were defined as BI-RADS® categories suspicious abnormality (code 4), highly suggestive of malignancy (code 5), or assessment incomplete (code 0)

Table 5 Age-adjusted rates by race/ethnicity and 95% confidence intervals per 1000 mammograms for abnormal mammograms and cancers detected for first and subsequent screening round(age-adjusted to year 2000 NBCCEDP population), July 1995–March 2002

	Race/ethnicity					
	All Races[a]	White, non-Hispanic	Black, non-Hispanic	Asian/ PacificIslander	American Indian/Alaskan Native	Hispanic
First round						
Mammograms – Total	789,647	405,197	133,843	33,995	39,080	157,561
Abnormal mammograms per1000 mammograms	111.8(111.1, 112.6)	113.2(112.1, 114.3)	110.4(108.5, 112.2)	106.5(103.0, 110.2)	79.3(76.1, 82.6)	118.2(116.4, 120.0)
Cancer detection						
Number of invasivecancers	5637	3565	956	163	158	682
Number of carcinomasin situ	1737	1039	317	80	62	202
Invasive cancers per1000 mammograms[b]	7.3(7.1, 7.5)	9.0(8.7, 9.4)	7.2(6.7, 7.7)	4.8(4.0, 5.6)	4.6(3.9, 5.5)	4.3(4.0, 4.7)
In situ cancers per1000 mammograms[b]	2.3(2.1,2.4)	2.6(2.5, 2.8)	2.4(2.1, 2.6)	2.4(1.9, 3.1)	1.8(1.3, 2.4)	1.3(1.1, 1.5)
Subsequent rounds						
Mammograms – Total	454,754	253,108	72,788	14,190	26,468	81,655
Abnormal mammogramsper 1000 mammograms	73.9(73.1, 74.7)	73.5(72.4, 74.6)	71.0(69.0, 73.2)	72.9(68.3, 77.8)	59.5(56.4, 62.6)	84.1(82.1, 86.2)
Cancer detection						
Number of invasivecancers	1160	718	192	28	72	136
Number of carcinomain situ	557	341	101	17	28	56
Invasive cancersper 1000 mammograms[c]	2.5(2.4, 2.7)	2.8(2.6, 3.0)	2.6(2.2, 3.0)	1.9(1.3, 2.8)	3.0(2.3, 3.8)	1.7(1.4, 2.0)
In situ cancers per1000 mammograms[c]	1.2(1.1, 1.3)	1.3(1.2, 1.5)	1.4(1.1,1.7)	1.3(0.73, 2.1)	1.0(0.62, 1.4)	0.7(0.51, 0.88)

[a] Includes 19,971 first round mammograms with unknown race and ethnicity, and 6,545 subsequent mammograms with unknown race and ethnicity

[b] First round cancer detection rate includes 37 *in situ* and 113 invasive cancers among race unknown

[c] Subsequent round cancer detection rates include 14 *in situ* and 14 invasive cancer in race unknown category

Table 6 Positive predictive value of abnormal mammogram for invasive or *in situ* cancers results by screening round, age group, and mammogram result, NBCCEDP, July 1995–March 2002

	Age									
	All ages		40–49		50–59		60–64		65 or greater	
	%	(95% CI)	%	(95% CI)	%	(95% CI)	%	(95% CI)	%	(95% CI)
First round										
Mammography result										
Suspicious abnormality	16.2	(15.6, 16.8)	12.6	(11.7,13.5)	16.6	(15.6, 17.5)	21.8	(20.0, 23.5)	20.7	(18.1, 23.3)
Highly suggestive of malignancy	74.9	(73.5, 76.3)	73.4	(70.5, 76.2)	75.3	(73.2, 77.4)	77.0	(74.0, 80.1)	72.1	(67.1, 77.2)
Assessment incomplete	2.8	(2.6, 2.9)	1.9	(1.7, 2.1)	2.8	(2.6, 2.9)	3.9	(3.5, 4.3)	4.6	(3.9, 5.2)
Total	7.9	(7.7, 8.1)	6.2	(5.9, 6.5)	7.6	(7.4, 7.9)	10.9	(10.3, 11.4)	11.7	(10.8, 12.6)
Subsequent rounds										
Mammography result										
Suspicious abnormality	13.6	(12.6, 14.6)	7.6	(5.8, 9.3)	13.8	(12.5, 15.2)	17.2	(14.9, 19.5)	18.0	(13.3, 22.7)
Highly suggestive of malignancy	61.2	(57.0, 65.4)	57.5	(46.2, 68.9)	63.0	(57.1,68.8)	62.5	(54.8, 70.2)	50.0	(33.7, 66.3)
Assessment incomplete	2.4	(2.2, 2.5)	1.4	(1.1, 1.7)	2.3	(2.1, 2.6)	3.0	(2.6, 3.4)	2.9	(2.0, 3.9)
Total	4.9	(4.7, 5.1)	3.1	(2.6, 3.5)	4.8	(4.5, 5.1)	6.2	(5.7, 6.8)	6.6	(5.4, 7.9)

The PPV for abnormal mammogram results was estimated as the number of cancers (*in situ* or invasive) diagnosed per 100 abnormal mammograms

detected early defined as AJCC Stage I or II, or SEER Summary stage local (Table 8). For subsequent rounds, the percent of cancers detected *in situ* was 32.4% and 53.6% of the cancers were detected at an early stage.

Discussion

We analyzed mammography and diagnostic follow-up data for 789,647 women whose first mammogram in the program occurred from 1 July 1995 through 31 March 2002. The majority (63.9%) of women examined by the program during this time period were between the ages of 50 and 64 years. A majority of women (65.1%) had only one mammogram within the NBCCEDP. However, a study of rescreening rates within the program found that 70% of women were re-screened within 18 months but using different funding sources [15]. Overall, the rate of abnormal mammograms, diagnostic follow-up and biopsy were highest among women aged 40 to 49 years. However, cancer detection rates were highest among women aged 60 to 64 years. The PPV for cancer of abnormal mammograms increased with increasing age and was highest in women aged 65 years and older. Among women with mammogram

Table 7 Positive predictive value of a biopsy for a cancer diagnosis following an abnormal mammogram by mammography results and age group for first and subsequent screening rounds, NBCCEDP, July 1995–March 2002

	Age									
	All ages		40–49		50–59		60–64		65 or greater	
	%	(95% CI)	%	(95% CI)	%	(95% CI)	%	(95% CI)	%	(95% CI)
First round										
Mammography result										
Suspicious abnormality	27.0	(26.0, 28.0)	22.0	(20.5, 23.6)	26.9	(25.4, 28.4)	34.1	(31.4, 36.8)	37.4	(33.0, 41.7)
Highly suggestive of malignancy	81.8	(80.3, 83.2)	78.4	(75.4, 81.4)	81.7	(79.6, 83.8)	84.9	(81.9, 87.8)	85.2	(80.5, 89.9)
Assessment incomplete	16.8	(16.1, 17.6)	11.5	(10.4, 12.6)	16.9	(15.9, 18.0)	23.3	(21.2, 25.5)	30.9	(26.8, 35.0)
Total	29.3	(28.7, 30.0)	23.1	(22.1, 24.1)	29.0	(28.0, 29.9)	37.9	(36.3, 39.6)	43.7	(40.9, 46.5)
Subsequent rounds										
Mammography result										
Suspicious abnormality	21.6	(20.0, 23.1)	11.9	(9.1, 14.7)	21.7	(19.6, 23.8)	26.9	(23.4, 30.4)	30.6	(23.2, 38.1)
Highly suggestive of malignancy	70.7	(66.3, 75.1)	62.7	(50.4, 75.1)	73.0	(66.9, 79.1)	72.0	(63.9, 80.1)	64.0	(45.2, 82.8)
Assessment incomplete	18.1	(16.8, 19.4)	11.2	(8.6, 13.8)	17.7	(16.0, 19.4)	23.6	(20.5, 26.7)	23.4	(16.3, 30.4)
Total	22.9	(21.8, 23.9)	14.2	(12.2, 16.2)	22.5	(21.1, 23.9)	28.9	(26.6, 31.2)	30.1	(25.0, 35.2)

Table 8 Reported stage at diagnosis by first and subsequent round, NBCCEDP, July 1995–March 2002

Stage	Percent	*N*
First round		
Carcinoma *in situ*	23.6	1737
AJCC Stage I	23.4	1722
AJCC Stage II	29.4	2167
AJCC Stage III	12.1	894
AJCC Stage IV	4.0	298
Summary local	2.5	182
Summary regional	1.7	122
Summary distant	0.33	24
Unknown/unstaged	3.1	228
Total	100.0	7374
Subsequent round		
Carcinoma *in situ*	32.4	557
AJCC Stage I	31.3	537
AJCC Stage II	20.3	348
AJCC Stage III	6.4	110
AJCC Stage IV	1.6	28
Summary local	2.0	35
Summary regional	1.1	19
Summary distant	0.29	5
Unknown/unstaged	4.5	78
Total	100.0	1717

BIRADS results highly suggestive of malignancy in the first round of screening, 74.9% were diagnosed with cancer.

A number of factors or limitations should be considered when reviewing the results of the NBCCEDP. The results of the screening program are influenced by the policies used to administer the NBCCEDP. For example, women who reported symptoms or who had an abnormal CBE were eligible for mammograms and diagnostic follow-up within the Program. Women with symptoms or a positive CBE are more likely to have abnormal mammograms and diagnostic follow-up than asymptomatic women being screened. The initial mammograms in women with symptoms or a positive CBE were not true screening evaluations but were included as such in the data. In addition, the program prioritized services to older women, requiring at least 75% of all paid mammograms to be provided to non-Medicare-enrolled women who were 50 years of age or older. Because of the requirements for screening older women, those who were younger than 50 years of age were less likely to be screened by the program but may have been referred into the program because they were believed to be at increased risk, had reported symptoms, or an abnormal screening test elsewhere. In addition, younger women have a greater breast density than post-menopausal women. Increased breast density decreases the sensitivity of mammography for detecting breast cancer and increases the false positive results leading to higher recall rates [16, 17]. These factors may explain why the rate of abnormal mammograms, abnormal CBEs, diagnostic follow-up, and biopsy were all highest in women aged 40 to 49 years compared to other age groups.

Although standard data collection forms were used within each Program there were variations across Programs in the overall methods used for data collection and in how individual variables were collected. For example, race may have been self-reported or assessed and recorded by the person enrolling the woman into the program. In addition, data on previous screening exams or symptoms may have been based on self-reports only and suffer from the limitations of all self-reported information. We have reported information on staging of the breast cancers detected. However, the type of information reported to individual Programs for assessing the stage of breast cancers detected as part of the NBCCEDP varied considerably. The stage reported in the NBCCEDP ranged from the stage reported in the state cancer registry to preliminary staging information from lumpectomy or other limited procedures. Therefore, the staging information in the NBCCEDP data may not be generally consistent with that from cancer registries.

Reported screening results from the NBCCEDP have changed over time. A previous analysis [7] presented data from 284,503 mammograms from 27 programs within the NBCCEDP in operation between program start up in 1991 and June 1995. The number of participating programs has risen sharply since 1995 and the characteristics of the population being screened have changed as well. For example, the proportion of women screened who were 50 years of age or older increased from 61% to 73%. Nonetheless, some comparisons can be made between the earlier report and our findings. The percent of women reported to have abnormal mammograms in the earlier analysis was lower than that found in our analysis for all age groups. For example, in women aged 50 to 59, 5.6% of women in the first screening round had an abnormal mammogram compared with 11.2% in our analysis. Overall, cancer detection (invasive and *in situ*) rates were lower in the earlier report than in our analysis with detection rates in the first screening round ranging from 3.6 per 1000 in women aged 40 to 49 years to 7.3 per 1000 in women over age 69 years. However, cancer detection rates reported previously are very similar to those in our analysis for women without reported symptoms. An increase in the number of women referred into the NBCCEDP due to symptoms or a positive CBE may explain the higher detection rates found in our analysis overall.

A thorough examination of mammography results and breast cancer detection by race and Hispanic ethnicity was reported for mammograms conducted between 1991 and March 1998 within the NBCCEDP [9]. As with the earlier analysis, age-specific cancer detection rates reported by May *et al.* [9] were lower than those found in our analysis. However, similar patterns between racial groups can be

assessed. For example, the percent of women with an abnormal mammogram was slightly higher among Hispanic women (8.8%) than among white women (7.7%) as in our analysis. Despite the higher rate of abnormal mammograms in both sets of analyses, the cancer detection rates among Hispanic women were among the lowest and were very similar to those among American Indian/Alaska Native women. The reason for the high rate of abnormal mammograms among Hispanic women despite their relatively low invasive cancer detection rate is not clear. In our analysis, American Indian/Alaska Native women tended to be younger (percent screened ages 40 to 49 years, 41.6%) but the age distribution among Hispanic women was similar to that among white, black and Asian/Pacific Islander women (29.8%; 25.7%, 23.4% and 25.8% of women ages 40 to 49 years, respectively). In our results the percent of mammograms with a BIRADS result of assessment incomplete was higher in Hispanic women (10.3%) compared to the overall population (8.9%) and compared to white women (8.7%). The same pattern was observed in the analysis by May, *et al*. [9]. In addition, our results indicated that the percent of women with an abnormal CBE was highest in white (6.0%) and Hispanic (5.4%) women and lowest among American Indian/Alaska native women (2.4%). White women have the highest cancer detection rates followed by black women in both analyses.

The NBCCEDP provides services to low-income and uninsured women. Government funded screening programs in other countries have different eligibility criteria; however, comparisons between programs are informative. Because the age of the population screened within the NBCCEDP was strongly influenced by program policies, women without reported symptoms and aged 50 to 59 years are the most comparable across different programs. We focused our comparisons on these women. (Table 9 provides the percent of women with diagnostic follow-up and cancer detection rates per 1000 mammograms for all women and those aged 50 to 59 years for the NBCCEDP, Canadian, and Victoria, Australia screening programs. Canada maintains a breast cancer screening program in all provinces, the Yukon and the Northwest Territories [18]. The program invites asymptomatic women between 50 and 69 years of age for breast cancer screening; however, women aged 40 to 49 years are accepted in over half of the provinces. Within the Canadian program there were 476,880 women screened for the first time in 1999 or 2000. Both diagnostic follow-up and cancer detection rates are higher in women screened within the NBCCEDP than for Canadian women. However, asymptomatic women in the NBCCEDP had diagnostic follow-up and invasive cancer detection rates that were more similar to those for the Canadian program.

Table 9 Diagnostic follow-up in percent (% recall) and cancer detection rates per 1000 mammograms in women being screened for the first time in the NBCCEDP, Canada, and Victoria

	NBCCEDP, July 1995–March 2002	NBCCEDP without symptoms	Canada, 1999–2000	Victoria, Australia, 2000
Diagnostic follow-up				
Total	15.4	12.8	12.0	10.6
Ages 50–59	14.6	12.7	12.5	11.0
Invasive cancer detection rates				
Total	7.1	3.9	4.7	5.9
Ages 50–59	6.8	3.7	4.1	4.8

Source: Refs. [18, 19]

A population-based breast cancer screening program in Victoria, Australia targeted asymptomatic women 50 to 69 years of age and screened 177,237 women in 2000 [19]. For women screened within the program for the first time, additional assessment was recommended for 10.6% of women based on abnormal mammography results, lower than diagnostic follow-up in Canada and in the NBCCEDP. Reported cancer detection rates for first screens within the Victoria program were higher than those in Canada and asymptomatic women in the NBCCEDP, but lower than those for the NBCCEDP overall.

Smith-Bindman, *et al*. [20] conducted a detailed comparison of data from the NBCCEDP in the US and the National Health Service Breast Screening Program (NHSBSP) in the UK. Because datasets were available from both screening programs, similar inclusion criteria could be used to compare screening outcomes from the two countries. In addition, data from the Breast Cancer Surveillance Consortium (BCSC) were compared to the two screening programs. The BCSC is a collaborative network of mammography registries established in 1994 by the National Cancer Institute with linkages to pathology data and tumor registries [21]. Definitions and procedures used in the Smith-Bindman analysis differ from those used in this paper for defining the first mammogram and screening *versus* diagnostic mammograms so that results cannot be directly compared between the two analyses. Based on her detailed analysis, Smith-Bindman, *et al*. reported that recall (diagnostic follow-up) rates were about twice as high in the US as in the U.K. but that cancer detection rates among the three datasets were similar. The high follow-up rates found in the NBCCEDP likely reflect general practices in the US as well as the effects of screening a medically underserved population, and screening women who are being referred into the program with symptoms or a positive CBE or mammogram conducted elsewhere.

Data from the NBCCEDP provide a rich source of information about the outcomes from mammography screening among low-income, uninsured women in the US.

Data collected as part of this program provide important information about screening outcomes and prevalent cancers in this population. The CDC funds programs to recruit women for screening and to improve access to screening and diagnostic services. Because the program reaches a traditionally under-screened population, the program provides a unique opportunity to reduce the burden of breast cancer in these women. For the most part, providers who screen women within the NBCCEDP should have similar practice patterns to all providers who screen low-income, uninsured women. Though the data are not population based, this program provides important information about breast cancer detection in a traditionally underserved population.

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