

Breast cancer screening of underserved women in the USA: results from the National Breast and Cervical Cancer Early Detection Program, 1998–2012

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Abstract

Objective To describe the number and proportion of eligible women receiving mammograms funded by the National Breast and Cervical Cancer Early Detection Program (NBCCEDP).

Methods Low-income, uninsured, and underinsured women aged 40–64 are eligible for mammography screening through the NBCCEDP. We used data from the NBCCEDP, the Current Population Survey, and Medical Expenditure Panel Survey to describe the number and proportion of women screened by the NBCCEDP and overall.

Results In 2011 and 2012, the NBCCEDP screened 549,043 women aged 40–64, an estimated 10.6 % (90 % confidence interval [CI] 10.4–10.9 %) of the eligible population. We estimate that 30.6 % (90 % CI 26.4–34.8 %) of eligible women aged 40–64 were screened outside the NBCCEDP, and 58.8 % (90 % CI 54.6–63.0 %) were not screened. The proportion of eligible women screened by the NBCCEDP varied across states, with an estimated range of 3.2 % (90 % CI 2.9–3.5 %) to 52.8 % (90 % CI 36.1–69.6 %) and a

median of 13.7 % (90 % CI 11.0–16.4 %). The estimated proportion of eligible women aged 40–64 who received mammograms through the NBCCEDP was relatively constant over time, 11.1 % (90 % CI 10.2–11.9 %) in 1998–1999 and 10.6 % (90 % CI 10.4–11.9 %) in 2011–2012 ($p = 0.23$), even as the number of women screened increased from 343,692 to 549,043.

Conclusions Although the NBCCEDP provided screening services to over a half million low-income uninsured women for mammography, it served a small percentage of those eligible. The majority of low-income, uninsured women were not screened.

Keywords Medically uninsured · Health services accessibility · Early detection of cancer · Mammography

Introduction

In 2009, the United States Preventive Services Task Force recommended that women aged 50–74 receive biennial mammograms [1]. However, lack of insurance coverage often serves as a barrier to women getting mammograms. Studies have shown that uninsured women are less likely to be screened [2, 3]. For example, in 2008, Oregon used a lottery to select uninsured, low-income adults off a waiting list for Medicaid coverage. Women randomly assigned to no insurance versus Medicaid coverage were 60 % less likely to have a mammogram [4]. Among those who have insurance coverage, there are still barriers to getting screened. Even small copayments have a large, negative effect on the proportion of women screened [5].

The US Congress passed the Breast and Cervical Cancer Mortality Prevention Act of 1990 (Public Law 101-354) to provide breast and cervical cancer screening services to

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention or the US Census Bureau.

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low-income, uninsured and underinsured women. The Act authorized the Centers for Disease Control and Prevention (CDC) to establish the National Breast and Cervical Cancer Early Detection Program (NBCCEDP). In 2012, the NBCCEDP provided \$158 million to 67 grantees. Grantees include all 50 states, the District of Columbia, five US territories, and 11 American Indian or Alaska Native organizations. Per congressional mandate, at least 60 % of federal funds received by the grantees must be spent on clinical services. The remaining 40 % are used to fund other components including program management, data collection, quality assurance and improvement, partnership development, professional education, public education, outreach, and evaluation. Treatment is covered by state Medicaid funding through the Breast and Cervical Cancer Treatment Act of 2000 (Public Law 106-354), the Native American Breast and Cervical Cancer Treatment Technical Amendment Act of 2001 (Public Law 107-121), and other outside sources. A detailed description of the history of the NBCCEDP is provided in a forthcoming paper [6].

The NBCCEDP provides both breast cancer screening services to low-income, uninsured women aged 40–64 and cervical cancer screening services to low-income, uninsured women aged 21–64. Most women older than 64 have coverage for screening through Medicare. (Estimates of program reach for cervical cancer screening are reported elsewhere in this monograph—Tangka et al. [7].) Although women aged 40–64 are eligible for breast cancer screening, NBCCEDP performance standards state that at least 75 % of federally funded mammograms be provided to the priority population of women aged 50 and older.

Previously, Tangka et al. [8] described the number of women screened for breast cancer by the NBCCEDP, the number of women eligible for screening services, and the proportion of eligible women screened by race/ethnicity and state. They found that the NBCCEDP screened 13.2 % (90 % CI 12.5–13.9) of eligible women 40–64 years old in 2002–2003. The NBCCEDP screened 16.4 % (90 % CI 14.7–18.1) of eligible Hispanic women, 10.4 % (90 % CI 9.2–11.6) of eligible non-Hispanic black women, and 11.2 % (90 % CI 10.4–12.0) of non-Hispanic white women. These types of data are useful for understanding the reach of the NBCCEDP and identifying populations that could benefit from better access to screening services. The objective of this study is to update Tangka et al.'s 2002–2003 analysis using data for 2011–2012. In addition, we expanded this analysis by describing trends in the numbers of women screened, the number of eligible women, and the proportion of eligible women screened from 1998 to 2012. The data do not permit us to distinguish between mammograms provided for purposes of screening versus diagnosis or follow-up of suspicious results. In keeping with standard NBCCEDP terminology and the

primary purpose of the NBCCEDP program, we refer to the “number of women screened” and “screening rates.” However, we recognize that we are using these terms more broadly than they are used in clinical settings.

Methods

Eligibility

Women aged 40–64 who do not have health insurance or whose insurance does not cover mammography screening are eligible for breast cancer screening through the NBCCEDP if their family incomes fall below state-specific income thresholds, which vary between 185 and 250 % of the federal poverty level. The federal poverty level was \$23,850 for a family of four in 2013 in the 48 contiguous states [9]. We used the 1998–2012 Annual Social and Economic Supplement to the Current Population Survey (CPS ASEC) conducted by the US Census Bureau to measure the number of eligible women by state, based on the federal poverty level selected by each state grantee. The Current Population Survey is a monthly national survey undertaken primarily to determine the characteristics of the labor force of the US civilian non-institutional population [10]. About 75,000 of the households participating in the Current Population Survey are included in the Annual Social and Economic Supplement. Respondents are asked a set of supplementary questions about health insurance coverage, income, and place of residence during the previous year [11]. The methods used to collect and report Current Population Survey and Annual Social and Economic Supplement data have been described previously [12]. We counted a woman as eligible if she was between the ages of 40 and 64, was uninsured, and had a family income at or below her state's income eligibility threshold. Respondents were considered uninsured if they were not covered by any type of private or government health insurance for the entire previous year [10].

Questions about age, family size, sex, race, and Hispanic origin were included in the basic Current Population Survey. Respondents were asked to identify their race by selecting one or more options from a list. Separately, respondents were asked about Hispanic origin. Following Census Bureau convention, we categorized women who reported that they were of Hispanic origin as Hispanic regardless of race. We categorized the remaining women, who were non-Hispanic, into one of the following racial groups: white, black, American Indian/Alaska Native, or Asian/Native Hawaiian/other Pacific Islander. We estimated the number of women eligible for the NBCCEDP by race and ethnicity (Hispanic origin) at the national level from CPS ASEC using Census Bureau methods [13].

Screening by the NBCCEDP

Data on the number of women screened by the NBCCEDP were obtained from data collected from NBCCEDP grantees (states, territories, and American Indian/Alaska Native organizations). Grantees collect income, family size, and insurance information to determine eligibility and collect and report to CDC standardized screening information on each encounter. These data include demographic characteristics, service dates, test performed, test results, and outcomes. Demographic data are self-reported. Reporting of race and Hispanic origin is optional. The structure of the NBCCEDP and methods for collecting and reporting data have been described in a *Morbidity and Mortality Weekly Report* paper [6].

We report the number of women screened by NBCCEDP over overlapping 2-year periods and the proportion of women screened. The number of women screened and the proportion of women screened were calculated independently for each 2-year period in accordance with current United States Preventive Services Task Force-recommended screening intervals [1]. We calculated the proportion of eligible women screened by NBCCEDP using the 2-year count from NBCCEDP as the numerator and the CPS 2-year estimate of eligible population as the denominator.

Screening outside the NBCCEDP

We used the Household Component of the Agency for Healthcare Research and Quality's Medical Expenditure Panel Survey (MEPS) to measure the proportion of women receiving mammograms in the eligible population. MEPS uses a 2-year overlapping panel design. The MEPS sample is drawn from the previous year's National Health Interview Survey sample and is designed to be representative of the civilian, non-institutionalized population. Respondents are interviewed five times over a two and a half-year period. Response rates vary by year and survey round but are approximately 60 % for the first round interviews. Respondents are asked "When did (PERSON) have (PERSON)'s most recent mammogram?" and are provided with a short, non-technical description of a mammogram if necessary. Response categories include a range of 1–5 years, "more than 5 years," and "never." The proportion of women screened calculated using MEPS closely matches the proportion calculated from the Health and Retirement Study but is higher than the proportion calculated using insurance claims [14]. Using the 2011 MEPS, we calculated the proportion of women aged 40–64 who were uninsured for the entire year, lived in households with incomes below 250 % of the federal poverty level, and reported having received a mammogram in the past

2 years. We applied sample weights to produce nationally representative estimates. We calculated the proportion of women having been screened outside the NBCCEDP by subtracting the proportion screened by the NBCCEDP from the proportion of the eligible population screened that we estimated using MEPS.

Data analysis

We report the number of women eligible for NBCCEDP screening, the number of women screened by the NBCCEDP, and the percentage of eligible women screened by the NBCCEDP by race and ethnicity group, age-group (40–64 and 50–64), year, and state. State designation is based on the woman's residence rather than the grantee program providing the service, and the state percentages include the screening data from American Indian/Alaska Native grantees. We report the number of women eligible and the proportion of women in the population who are eligible in each state. In compliance with the NBCCEDP data use agreement, grantee- and state-specific reports of the number and proportion of women screened are de-identified.

Screening totals and proportions based on NBCCEDP data represent mammograms provided with NBCCEDP funds. There was one state that included mammograms paid for by state appropriations in its reports of NBCCEDP-funded mammograms over the period from 2002 to 2006. The state discontinued this reporting approach in 2006. While the combined data may better represent results of publicly funded screening for low-income uninsured women, this paper is limited NBCCEDP-funded services. Lacking these data for the period 2002–2006, we used linear interpolation to estimate the number of women screened by NBCCEDP and the proportion of eligible women screened by NBCCEDP over this period.

Estimates of the number of women eligible are based on a random sample of the population and are thus subject to sampling error. Estimates of variance for estimates of the number of women eligible and the proportion of eligible women screened in the US population account for the complex survey design of the CPS ASEC [11] and MEPS [15]. Methods for computing confidence intervals for the estimates of the eligible population have been described previously [8]. Consistent with Census Bureau convention, we report 90 % confidence intervals for estimates of the eligible population and the percent of the eligible population who received mammograms through the NBCCEDP. Confidence intervals for the proportion of women screened outside the NBCCEDP account for uncertainty in the estimate of the proportion of women screened by the NBCCEDP and uncertainty in the estimate of the proportion of eligible women screened overall (from MEPS). We

use *t* tests to assess the significance of differences in the proportion of women screened between periods, assuming independent variances. We treated the number of eligible women screened by the NBCCEDP as an exact count with no error. We estimated least-squares regressions where yearly counts of the number of women screened, counts of the number of eligible women, and the proportion of eligible women screened were dependent variables and the independent variable was year (a continuous variable running from 1999 to 2012) to assess the significance of trends.

Results

The NBCCEDP screened 549,043 women aged 40–64 in 2011 and 2012, an estimated 10.6 % (90 % CI 10.4–10.9 %) of the 5 million women eligible for breast screening through NBCCEDP. The NBCCEDP screened 476,651 women aged 50–64, an estimated 17.3 % (90 % CI 16.7–18.0 %) of the eligible women in the age-group. Figure 1 shows the proportion of eligible women screened using NBCCEDP funds and using funds from other sources by age-group. Using the MEPS, we estimated that 30.6 % (90 % CI 26.4–34.8 %) of eligible women aged 40–64 received a mammogram outside the NBCCEDP in 2011–2012. More than half of eligible women aged 40–64 women—an estimated 58.8 % (90 % CI 54.6–63.0 %)—did not receive a mammogram. We estimated that 26.5 % (90 % CI 18.8–34.2 %) of eligible women aged 50–64 received a mammogram outside the NBCCEDP in 2011–2012 and 56.2 % (90 % CI 48.5–63.9 %) were not screened.

Table 1 reports the number of women eligible for NBCCEDP screening and the number and proportion of these women who received mammograms through the NBCCEDP by race and ethnicity. Among women aged 40–64, the estimated proportion of women eligible ranged

from 6.7 % (90 % CI 6.4–7.0 %) among non-Hispanic white women to 22.4 % (90 % CI 21.4–23.4 %) among Hispanic women. The estimated proportion of eligible women screened ranged from 8.7 % (90 % CI 8.4–9.1 %) among Hispanic women to 33.1 % (90 % CI 25.8–40.3 %) of American Indians and Alaska Natives. Among women aged 50–64, the estimated proportion of women eligible ranged from 6.2 % (90 % CI 5.8–6.6 %) among non-Hispanic white women to 19.9 % (90 % CI 18.5–21.3 %) among Hispanic women. The estimated proportion of eligible women screened ranged from 15.8 % (90 % CI 14.9–16.6 %) among non-Hispanic white women to more than half of American Indians and Alaska Natives.

Table 2 reports the number and proportion of women eligible by state. Figure 2 depicts the proportion of eligible women who received mammograms through the NBCCEDP by state. The horizontal lines represent the proportion of all eligible women screened in the USA. Two states are excluded from comparison because they use different program implementation or eligibility criteria. The proportion of eligible women screened by the NBCCEDP varied across states, with an estimated range of 3.2 % (90 % CI 2.9–3.5 %) to 52.8 % (90 % CI 36.1–69.6 %) and a median of 13.7 % (90 % CI 11.0–16.4 %). The estimated 25th and 75th percentiles, reflecting the markers that are the third from the left and third from the right on the figure, are 8.7 % (90 % CI 7.4–10.0 %) and 24.4 % (90 % CI 17.2–31.7 %). For women aged 50–64, the estimated range is 6.3 % (90 % CI 5.5–7.0 %) to 83.8 % (90 % CI 43.5–124.0 %) with an estimated median of 21.6 % (90 % CI 14.5–28.8 %). The estimated 25th and 75th percentiles are 13.7 % (90 % CI 10.1–16.0 %) and 35.9 % (90 % CI 25.5–68.8 %), respectively.

Table 3 reports the number of women eligible for screening and the number and proportion of eligible women screened by period and by age-group. Differences in the proportions of eligible women who were screened by NBCCEDP between 1998–1999 and 2011–2012 were not statistically significant in either age-group ($p = 0.23$ for women aged 40–64 and $p = 0.44$ for women aged 50–64).

Figure 3 shows the number of women eligible for screening, the number of women screened through the NBCCEDP, and the proportion of NBCCEDP-eligible women screened through the NBCCEDP by year. Screening figures for the period 2002–2006 are interpolated. The estimated number of women who were eligible for screening and the number of women screened through the NBCCEDP increased over the study period. The estimated number of eligible women aged 40–64 increased from 3.1 million (90 % CI 2.9–3.4) in 1998–1999 to 5.2 million (90 % CI 5.0–5.3) in 2011–2012 ($p < 0.001$). The estimated number of eligible women aged 50–64 increased

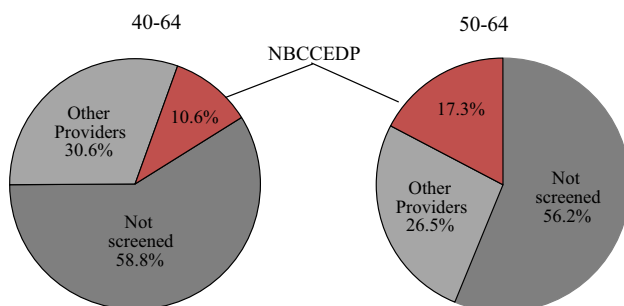


Fig. 1 Percentage of low-income uninsured women screened for breast cancer in the USA, 2011–2012. *Source:* Authors' tabulations of modified data from Medical Expenditure Panel Survey 2011, US Census Bureau, Current Population Survey, 2011–2012 Annual Social and Economic Supplements, and from NBCCEDP October 2013 data

Table 1 National Breast and Cervical Cancer Early Detection Program (NBCCEDP) Eligibility and Screening for Breast Cancer, by age-group, race, and ethnicity, 2011–2012

Race/ethnicity	US population ^a Number (in thousands)	Women eligible for NBCCEDP screening ^b				Eligible women screened for breast cancer via NBCCEDP		
		Number (in thousands)	(90 % CI)	Percent ^c	(90 % CI)	Number	Percent ^d	(90 % CI)
40–64								
Total	52,838	5,160	(5,027–5,293)	9.8	(9.5–10.1)	549,043	10.6	(10.4–10.9)
Non-Hispanic	46,201	3,675	(3,561–3,790)	8	(7.8–8.2)	412,126	11.2	(10.9–11.6)
White	36,320	2,422	(2,326–2,518)	6.7	(6.4–7.0)	253,348	10.5	(10.0–10.9)
Black	6,555	908	(854–961)	13.8	(13.0–14.6)	101,838	11.2	(10.6–11.9)
AIAN	341	57	(45–70)	16.7	(13.2–20.2)	18,889	33.1	(25.8–40.3)
ANHOPI	2,984	289	(258–320)	9.7	(8.7–10.7)	35,365	12.2	(10.9–13.5)
Multiracial	–	–	–	–	–	2,686	–	–
Hispanic	6,637	1,485	(1,419–1,550)	22.4	(21.4–23.4)	129,769	8.7	(8.4–9.1)
Unknown	–	–	–	–	–	9,834	–	–
50–64								
Total	31,454	2,751	(2,646–2,856)	8.7	(8.4–9.0)	476,651	17.3	(16.7–18.0)
Non-Hispanic	28,197	2,103	(2,012–2,195)	7.5	(7.2–7.8)	361,476	17.2	(16.4–17.9)
White	22,622	1,407	(1,328–1,486)	6.2	(5.8–6.6)	221,653	15.8	(14.9–16.6)
Black	3,789	518	(480–556)	13.7	(12.7–14.7)	90,976	17.6	(16.3–18.8)
AIAN	182	27	(18–36)	15	(10.3–19.7)	14,326	52.4	(35.0–69.9)
ANHOPI	1,604	151	(129–173)	9.4	(8.1–10.7)	32,278	21.4	(18.3–24.4)
Multiracial	–	–	–	–	–	2,243	–	–
Hispanic	3,257	647	(601–693)	19.9	(18.5–21.3)	109,061	16.8	(15.6–18.0)
Unknown	–	–	–	–	–	8,357	–	–

AIAN American Indian/Alaska Native; ANHOPI Asian, Native Hawaiian, and Pacific Islander. Details may not sum to totals because of rounding

^a The US population represents the Current Population Survey sample universe which consists of the resident civilian non-institutionalized population of the USA

^b Women eligible for NBCCEDP-funded mammograms include those 40–64 years of age who are uninsured and have low income (based on eligibility criteria used in each state) aggregated to the nation. The number of eligible women could be underestimated because it excludes those who have health insurance but whose insurance does not cover breast cancer screening and those who are uninsured for less than 1 year. See “Methods” section for details

^c Percent of all US women in a given age-group, racial group, and ethnic group who were eligible for NBCCEDP-funded mammograms

^d Percent of all US women in a given age-group, racial group, and ethnic group who were eligible and who were provided with NBCCEDP-funded mammograms

Source: Authors’ tabulations of modified data from the US Census Bureau, Current Population Survey, 2011–2012 Annual Social and Economic Supplements, and from NBCCEDP October 2013 data

from 1.5 million (90 % CI 1.3–1.6) in 1998–1999 to 2.8 million (90 % CI 2.6–2.9) in 2011–2012 ($p < 0.001$). The number of women aged 40–64 who were screened through the NBCCEDP increased from 344,000 in 1998–1999 to 549,000 in 2011–2012 (we do not report a p value because these are exact values). The number of women aged 50–64 who were screened increased from 265,000 in 1998–1999 to 477,000 in 2011–2012.

Increases in the number of women eligible for screening offset increases in the number of women screened, leaving the estimated proportion of women screened relatively unchanged. Note that trends in the proportion of women

screened between 2002 and 2006 incorporate interpolated values for the number of women screened (the numerator). Estimates of the number of women eligible (the denominator) were not interpolated.

The difference in estimates of the proportion of eligible women aged 40–64 who were screened through the NBCCEDP between the beginning and the end of the study period was nonsignificant [11.1 % (90 % CI 10.2–11.9 %) in 1998–1999 and 10.6 % (90 % CI 10.4–10.9 %) in 2011–2012; $p = 0.23$]. Similarly, the difference in estimates of the proportion of eligible women aged 50–64 who were screened between the beginning and the end of the study

Table 2 Estimated number of women eligible for breast cancer screening in NBCCEDP, by state: 2-year averages for 2011–2012

	Poverty criterion ^c		40–64				50–64					
			US population ^a		Eligible women ^b		US population ^a		Eligible women ^b			
	Number ^d	% Of total ^e	Number ^d	(90 % CI) ^d	Number ^d	(90 % CI) ^d	Number ^d	(90 % CI) ^d	Number ^d	(90 % CI) ^d		
US	52,838	5,160	5,160	(5,027–5,293)	9.8	(9.5–10.1)	31,454	(2,646–2,856)	2,751	(2,646–2,856)	8.7	(8.4–9.0)
Alabama	200	870	79	(60–98)	9.1	(6.9–11.3)	536	(28–53)	40	(28–53)	7.5	(5.3–9.7)
Alaska	250	116	15	(12–18)	13.0	(10.5–15.5)	73	(7–12)	9	(7–12)	12.8	(9.5–16.1)
Arizona	250	1,093	145	(118–172)	13.3	(10.8–15.8)	654	(60–98)	79	(60–98)	12.1	(9.1–15.1)
Arkansas	200	470	67	(53–81)	14.2	(11.2–17.2)	285	(26–46)	36	(26–46)	12.7	(9.3–16.1)
California	200	6,185	711	(659–762)	11.5	(10.7–12.3)	3,654	(333–417)	375	(333–417)	10.3	(9.2–11.4)
Colorado	250	835	69	(57–80)	8.2	(6.8–9.6)	491	(27–47)	37	(27–47)	7.6	(5.6–9.6)
Connecticut	200	660	20	(14–27)	3.1	(2.1–4.1)	389	(6–14)	10	(6–14)	2.5	(1.5–3.5)
Delaware	250	160	8	(6–11)	5.3	(3.8–6.8)	98	(2–6)	4	(2–6)	4.1	(2.5–5.7)
District of Columbia	250	89	5	(4–6)	5.7	(4.2–7.2)	50	(3–4)	3	(2–4)	5.6	(3.5–7.7)
Florida	200	3,451	422	(372–471)	12.2	(10.8–13.6)	2,065	(193–269)	231	(193–269)	11.2	(9.5–12.9)
Georgia	200	1,708	205	(174–236)	12.0	(10.2–13.8)	971	(88–138)	113	(88–138)	11.7	(9.2–14.2)
Hawaii	250	224	15	(12–19)	6.8	(5.3–8.3)	145	(7–13)	10	(7–13)	6.8	(4.8–8.8)
Idaho	200	237	22	(16–28)	9.2	(6.8–11.6)	141	(6–13)	9	(6–13)	6.6	(4.0–9.2)
Illinois	250	2,116	209	(180–239)	9.9	(8.5–11.3)	1,215	(94–141)	117	(94–141)	9.6	(7.7–11.5)
Indiana	200	1,047	95	(69–120)	9.0	(6.6–11.4)	643	(34–75)	54	(34–75)	8.5	(5.4–11.6)
Iowa	250	521	31	(24–38)	5.9	(4.7–7.1)	325	(10–22)	16	(10–22)	4.9	(3.2–6.6)
Kansas	225	440	32	(23–40)	7.2	(5.2–9.2)	266	(7–19)	13	(7–19)	4.8	(2.6–7.0)
Kentucky	250	738	87	(71–104)	11.8	(9.6–14.0)	437	(30–60)	45	(30–60)	10.4	(7.2–13.6)
Louisiana	250	755	132	(106–159)	17.5	(14.2–20.8)	453	(55–94)	75	(55–94)	16.5	(12.6–20.4)
Maine	250	262	19	(14–23)	7.1	(5.3–8.9)	168	(8–16)	12	(8–16)	6.9	(4.6–9.2)
Maryland	250	1,058	71	(57–85)	6.7	(5.4–8.0)	610	(22–41)	32	(22–41)	5.2	(3.7–6.7)
Massachusetts	250	1,171	17	(8–26)	1.4	(0.7–2.1)	670	(1–14)	8	(1–14)	1.2	(0.2–2.2)
Michigan	250	1,724	157	(132–182)	9.1	(7.7–10.5)	1,062	(59–94)	77	(59–94)	7.2	(5.6–8.8)
Minnesota	250	882	35	(26–43)	3.9	(2.9–4.9)	541	(11–25)	18	(11–25)	3.4	(2.1–4.7)
Mississippi	250	484	51	(37–64)	10.5	(8.0–13.0)	295	(21–42)	32	(21–42)	10.7	(7.5–13.9)
Missouri	200	1,019	80	(60–100)	7.8	(5.9–9.7)	598	(23–47)	35	(23–47)	5.8	(3.8–7.8)
Montana	200	159	21	(16–25)	12.8	(10.1–15.5)	106	(10–17)	14	(10–17)	12.6	(9.3–15.9)
Nebraska	225	298	18	(14–22)	6.2	(4.9–7.5)	186	(5–11)	8	(5–11)	4.4	(2.9–5.9)
Nevada	250	437	66	(56–77)	15.2	(12.8–17.6)	261	(29–46)	38	(29–46)	14.4	(11.2–17.6)
New Hampshire	250	254	17	(14–21)	6.8	(5.5–8.1)	155	(7–13)	10	(7–13)	6.3	(4.5–8.1)
New Jersey	250	1,536	148	(124–172)	9.6	(8.0–11.2)	916	(64–102)	83	(64–102)	9.0	(7.0–11.0)
New Mexico	250	353	51	(41–61)	14.5	(11.8–17.2)	212	(20–37)	29	(20–37)	13.6	(10.1–17.1)

Table 2 continued

	Poverty criterion ^c 40–64		50–64	
	US population ^a		US population ^a	
	Number ^d	Eligible women ^b Number ^d (90 % CI) ^d	Number ^d	Eligible women ^b Number ^d (90 % CI) ^d
New York	250	217 (185–249)	1,968	114 (90–137)
North Carolina	250	186 (158–214)	953	92 (67–116)
North Dakota	200	5 (3–6)	73	3 (1–4)
Ohio	200	164 (133–196)	1,157	91 (71–111)
Oklahoma	185	59 (44–74)	354	31 (19–44)
Oregon	250	61 (47–75)	436	36 (26–46)
Pennsylvania	250	179 (152–205)	1,384	93 (73–113)
Rhode Island	250	16 (12–19)	113	8 (6–10)
South Carolina	200	92 (73–112)	528	51 (36–65)
South Dakota	200	8 (6–10)	82	4 (3–6)
Tennessee	250	131 (106–157)	663	82 (62–102)
Texas	200	573 (525–621)	2,326	291 (256–326)
Utah	250	28 (20–37)	212	14 (7–21)
Vermont	250	4 (2–5)	72	3 (1–4)
Virginia	200	106 (86–126)	820	55 (42–69)
Washington	250	116 (93–139)	735	61 (48–75)
West Virginia	200	31 (25–38)	226	16 (10–22)
Wisconsin	250	55 (39–71)	623	31 (19–42)
Wyoming	250	9 (7–11)	61	5 (4–7)

Details may not sum to totals because of rounding

^a The US population represents the Current Population Survey sample universe which consists of the resident civilian non-institutionalized population of the USA

^b Women eligible for NBCCEDP-funded mammograms include those aged 40–64 who are uninsured and have low income (based on eligibility criteria used in each state) aggregated to the nation. The number of eligible women could be underestimated because it excludes those who have health insurance but whose insurance does not cover breast cancer screening and those who are uninsured for less than 1 year. See “Methods” section for details

^c 30 states and District of Columbia set income eligibility at 250 % of poverty, 18 states at 200 % of poverty, two states at 225 %, and one state at 185 % of poverty. The estimated number of women for the USA is based on the eligibility criteria used in each state

^d Number in thousands

^e Eligible women as percentage of all women in a given age in that state

Source: Authors’ tabulations of modified data from the US Census Bureau, Current Population Survey, 2011–2012 Annual Social and Economic Supplements

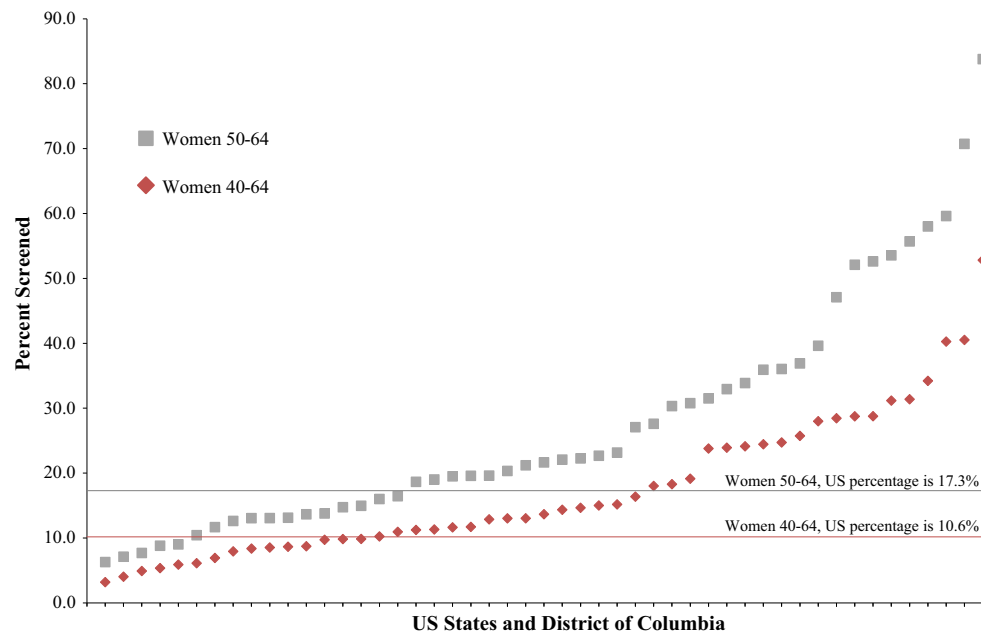


Fig. 2 Percent of NBCCEDP-eligible women screened for breast cancer by state and District of Columbia compared to national average, 2011–2012. *Source:* Authors' tabulations of modified data from the US Census Bureau, Current Population Survey, 2011–2012 Annual Social and Economic Supplements, and from NBCCEDP October 2013 data. *Notes:* The symbols show the percentage of

eligible women screened by each state and District of Columbia. Two states that used different eligibility/implementation criteria are not included. Data points for each age-group sorted by percentage of eligible women screened. The proportion of women screened by the NBCCEDP across the USA is 10.6 % aged 40–64 and 17.3 % aged 50–64

period was nonsignificant [17.5 % (90 % CI 15.5–19.6 %) in 1998–1999 and 17.3 % (90 % CI 16.7–18.0 %) in 2011–2012; $p = 0.44$].

In 2007–2008, the estimated proportion of eligible women aged 40–64 screened by NBCCEDP was 11.9 % (90 % CI 11.6–12.3 %). The estimated proportion was 10.3 % (90 % CI 10.1–10.6 %) in 2010–2011, a decrease of 1.6 % (90 % CI 0.8–1.8 %) percentage points ($p < 0.001$). However, the estimated proportion of eligible women aged 50–64 screened by NBCCEDP declined from 20.8 % (90 % CI 20.0–21.7 %) in 2007–2008 to 17.2 % (90 % CI 16.8–17.8 %) in 2010–2011, a decrease of 3.6 % (90 % CI 2.5–4.7 %) percentage points ($p < 0.001$).

Figure 4 shows trends in the estimated proportion of eligible women screened aged 50–64 by race and ethnicity. Screening rates for American Indians and Alaskan Natives, which are much higher than for other groups, are shown on a separate graph to facilitate display. Estimates of changes in the proportion of women screened over the study period for black [from 16.0 % (90 % CI 11.6–20.4 %) to 17.6 % (90 % CI 16.3–18.8 %)], Asian/Native Hawaiian, other Pacific Islander [from 17.3 % (90 % CI 10.2–11.9 %) to 21.4 % (90 % CI 10.2–11.9 %)], Hispanic [from 14.3 % (90 % CI 10.6–18.0 %) to 16.9 % (90 % CI 15.7–18.0 %)], and white women [from 17.9 % (90 % CI 15.0–20.7 %) to 15.8 % (90 % CI 14.9–16.6 %)] were nonsignificant.

Discussion

We estimated that the NBCCEDP screened about 10.6 % (90 % CI 10.4–10.9 %) of eligible women aged 40–64 for breast screening in 2011–2012. An estimated 30.6 % (90 % CI 26.4–34.8 %) of eligible women aged 40–64 are screened outside NBCCEDP, leaving around 58.8 % (90 % CI 54.6–63.0 %) of eligible women not screened with a 2-year period. The comparable figure from the Center for Disease Control and Prevention's *Health, United States, 2013* report, which was calculated using the 2010 National Health Interview Survey, is 64 % (see Table 83 [16]). *Health, United States, 2013* reports that 24.4 % of women aged 40–64 with private insurance were not screened and 35.6 % of women aged 40–64 with Medicaid were not screened. Screening under the NBCCEDP yields an estimated benefit of 0.056 life years per women screened, and women who are not screened forgo this benefit [17].

The proportion of women screened may vary across grantees because of differences in funding, the costs of delivering, and grantee-specific eligibility criteria and the characteristics of eligible women. Some grantees supplement CDC funds with funds allocated from the state budget, and funding from the CDC to grantees is not directly tied to the number of eligible women. Thus, the number of grant dollars per eligible woman varies across states. The

Table 3 NBCCEDP trends in the number of women eligible and the number and percent of women screened for breast cancer

Year	Women eligible for NBCCEDP screening		Eligible women screened for breast cancer via NBCCEDP		
	Number (in thousands)	(90 % CI)	Number (in thousands)	Percent of eligible screened	(90 % CI)
40–64					
1998–1999	3,110	(2,861–3,360)	344	11.1	(10.2–11.9)
1999–2000	3,018	(2,806–3,230)	367	12.2	(11.3–13.0)
2000–2001	3,089	(2,912–3,267)	391	12.7	(11.9–13.4)
2007–2008	4,037	(3,918–4,157)	482	11.9	(11.6–12.3)
2008–2009	4,526	(4,394–4,657)	513	11.3	(11.0–11.7)
2009–2010	5,039	(4,892–5,185)	533	10.6	(10.3–10.9)
2010–2011	5,230	(5,083–5,377)	541	10.3	(10.1–10.6)
2011–2012	5,160	(5,027–5,293)	549	10.6	(10.4–10.9)
Change	2,050		205	–0.41	
50–64					
1998–1999	1,459	(1,287–1,631)	256	17.5	(15.5–19.6)
1999–2000	1,419	(1,273–1,565)	279	19.7	(17.6–21.7)
2000–2001	1,446	(1,324–1,568)	297	20.6	(18.8–22.3)
2007–2008	1,994	(1,912–2,076)	415	20.8	(20.0–21.7)
2008–2009	2,198	(2,111–2,285)	445	20.3	(19.5–21.1)
2009–2010	2,523	(2,423–2,624)	459	18.2	(17.5–18.9)
2010–2011	2,738	(2,629–2,847)	470	17.2	(16.5–17.8)
2011–2012	2,751	(2,646–2,856)	477	17.3	(16.7–18.0)
Change	1,292		221	–0.2	

Details may not sum to totals because of rounding

Source: Authors' tabulations of modified data from the US Census Bureau, Current Population Survey, 2011–2012 Annual Social and Economic Supplements, and from NBCCEDP October 2013 data

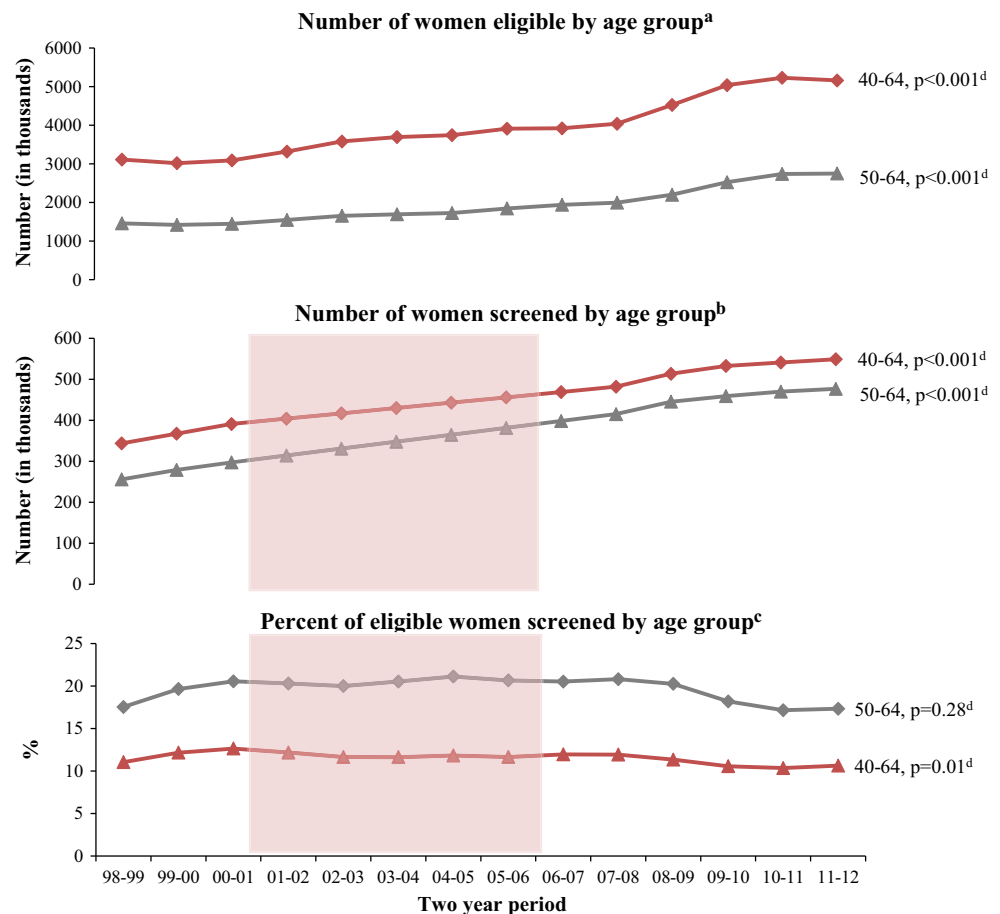
cost of delivery, which includes the cost of transportation and the cost of mammograms, may also vary across states. Eligibility criteria influence screening rates via their impact on the composition of the pool of eligible women. For example, the types of women who are eligible will differ between states that include women with incomes up to 200 % of the poverty level and states that include women with incomes up to 250 % of the poverty level. Differences in the propensity to be screened between women with incomes below and above 200 % of the poverty level may explain some of the differences in state-level screening rates. Likewise, many grantees start routine breast screening in women age 50 and older but offer services to symptomatic women at any age. The population of NBCCEDP-eligible women in a state with broader Medicaid coverage criteria may include a higher proportion of women with incomes between 100 and 250 % of the poverty level because those below have coverage for mammograms through Medicaid.

We estimated the number of women eligible for NBCCEDP screening and the number of eligible women screened outside of the NBCCEDP by applying eligibility criteria to the Annual Social and Economic Supplement

and the Medical Expenditure Panel Survey. We expect that these figures are measured with error [18]. Survey respondents may misreport their incomes and insurance status, and estimates are subject to non-response bias. Restricting attention to women uninsured for the entire year overlooks women who are uninsured for only a part of the year and would be eligible for the NBCCEDP while they are uninsured. Likewise, there is a mismatch in the period over which we measured the receipt of a mammogram in the Medical Expenditure Panel Survey (2 years) and the period over which we measured insurance coverage (1 year). Some women we counted as eligible may have been insured when they received a mammogram. For this reason, our estimates of the proportion of eligible women who received a mammogram outside the NBCCEDP may be overstated.

In many states, only women with incomes below 200 % of the poverty level are eligible for NBCCEDP-funded mammograms. Our estimate of the proportion of women who are screened outside the NBCCEDP and women who are not screened is based on a sample that includes women with incomes below 250 % of the poverty level. Our estimates may look different if we restricted the sample to

Fig. 3 Trends in NBCCEDP-eligible population and reach for breast cancer screening by age-group. *Source:* Authors' tabulations of modified data from the US Census Bureau, Current Population Survey, 2011–2012 Annual Social and Economic Supplements, and from NBCCEDP October 2013 data. *Note:* The numbers and percentages in the shaded region of the graph are interpolated values



^aWomen eligible for NBCCEDP-funded Mammograms include those 40-64 years of age who are uninsured, and have low-income (based on eligibility criteria used in each state) aggregated to the nation. The number of eligible women could be underestimated because it excludes those who have health insurance but whose insurance does not cover breast cancer screening and those who are uninsured for less than one year. See methods section for details.

^bPercent of all US women in a given age group who were eligible for NBCCEDP-funded Mammograms.

^cPercent of all US women in a given age group who were eligible and who were provided with NBCCEDP-funded Mammograms.

^dP-values are for tests of trends.

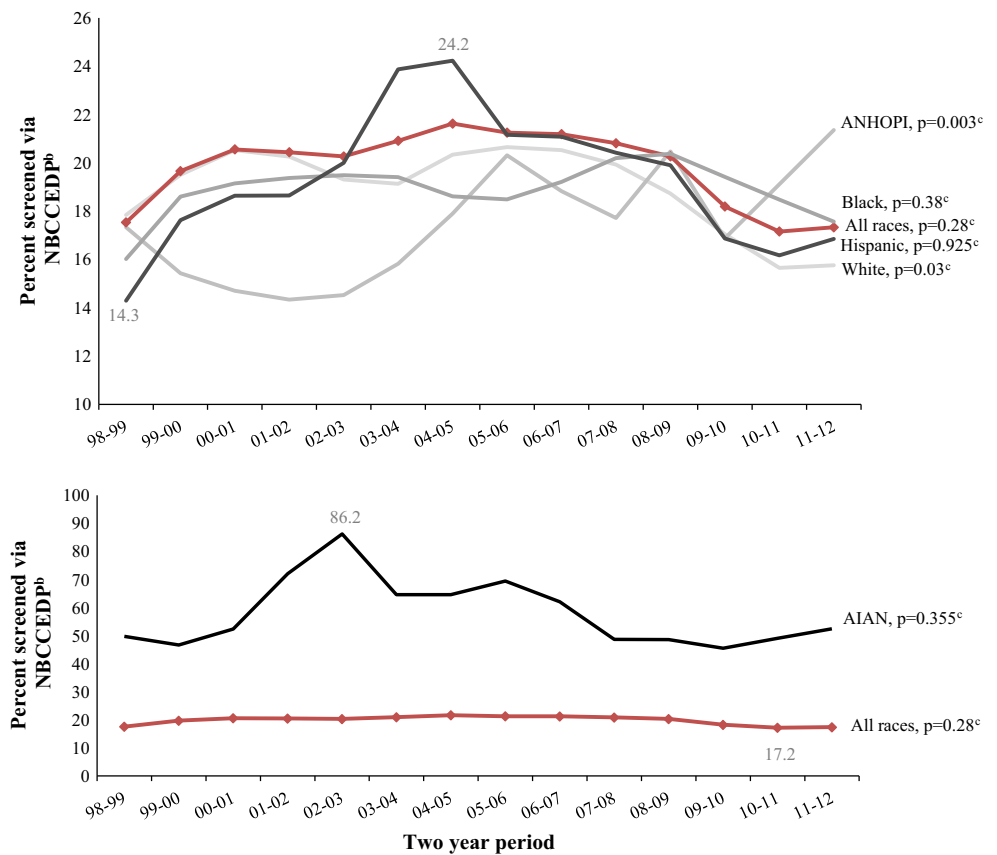
women with incomes below 200 % of the poverty level. We suspect that fewer would receive mammograms outside the NBCCEDP.

We do not know how many women have low incomes and are underinsured (i.e., in plans that do not cover mammography) and thus eligible for services. For this reason, we may underestimate the proportion of women eligible.

Our study builds on the work of Tangka et al. [8], who described the number of women eligible for screening through the NBCCEDP and the proportion screened for the period 2002–2003. They reported that the NBCCEDP screened 529,000 women aged 40–64, 13.2 % (90 % CI 12.5–13.9) of the eligible population. We found that in 2011–2012, the NBCCEDP screened more women, 549 thousand, but the estimated proportion of eligible women screened by NBCCEDP was lower, 10.6 % (90 % CI 10.4–10.9 %). Increases in the number of women eligible for the NBCCEDP have exceeded increases in the capacity and funding of NBCCEDP and its grantees to provide mammograms.

In 2009, the United States Preventive Services Task Force issued new breast cancer screening recommendations [1]. The major change from the previous version was that the Task Force no longer recommended that women aged 40–49 be routinely screened for breast cancer. Previous studies have found that there was a small [19–21] or no [22] decrease in the proportion of women screened in this age-group after 2009. We did not specifically measure the proportion of women screened who were aged 40–49. However, comparing trends in the proportion of women screened among women 40–64 and 50–64, it does not appear as if the Task Force recommendation had much, if any, impact on the proportion of women screened by NBCCEDP. NBCCEDP established a policy in 1996 to prioritize mammography for women 50 years of age or older, and this age-group has been the priority of the NBCCEDP since that time [3]. The proportion of women aged 40–49 screened by NBCCEDP is sufficiently small that it is difficult to detect an impact of the revised 2009 USPSTF recommendation, if any. Many of the women

Fig. 4 NBCCEDP trends in the percent of eligible women screened for breast cancer, aged 50–64, by race and ethnicity^a. *Source:* Authors’ tabulations of modified data from the US Census Bureau, Current Population Survey, 2011–2012 Annual Social and Economic Supplements, and from NBCCEDP October 2013 data. *Notes:* AIAN American Indian or Alaska Native; ANHOPI Asian American, Native Hawaiian, or Pacific Islander. Highest and lowest points are marked to point out scale



^aWomen eligible for NBCCEDP-funded Mammograms include those who are uninsured, and have low-income (based on eligibility criteria used in each state) aggregated to the nation. The number of eligible women could be underestimated because it excludes those who have health insurance but whose insurance does not cover breast cancer screening and those who are uninsured for less than one year. See methods section for details.
^bPercent of all US women ages 50-64 years in a given racial and ethnic group who are eligible and who were provided with NBCCEDP-funded Mammograms.
^cP-values are for tests for trends.

aged 40–49 screened by NBCCEDP grantees are symptomatic [23], and so we would not necessarily expect to see a decline in the proportion screened.

Our data predate many of the major insurance coverage expansions under the Affordable Care Act. Previously, Levy et al. [24] estimated that there will be 1.7 million low-income uninsured women aged 40–64 who remain eligible for the NBCCEDP in 2014 after implementation of the Affordable Care Act’s major insurance expansion provisions. They conclude that the NBCCEDP “will still only be able to meet the needs of one-fifth to one-third of those eligible.” Levy et al. assumed that coverage expansions under the Affordable Care Act would mirror the expansions that occurred in Massachusetts after it implemented its reform in 2006. They also assumed that all states would expand Medicaid. In April 2014, the Congressional Budget Office projected that 30 million non-elderly adults will be uninsured in 2016 and beyond given what was known about states’ expansion of Medicaid at the time [25]. Twenty-three states have not yet expanded Medicaid. There are roughly 5 million uninsured adults in these states who do not qualify for Medicaid (under

the pre-Affordable Care Act policies that remain in place) but do not earn enough to receive subsidies to buy insurance on the Health Insurance Marketplaces [26]. The number of uninsured women will increase if the Supreme Court rules that the Affordable Care Act prohibits the federal government for providing subsidies to people who buy insurance through federally operated exchanges (as opposed to state-based exchanges). Either way, we expect that the number of uninsured will continue to outpace the capacity of the NBCCEDP to provide cancer screenings.

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Conflict of interest None.

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Erratum to: Breast cancer screening of underserved women in the USA: results from the National Breast and Cervical Cancer Early Detection Program, 1998–2012

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In the original publication of the article, reference 7 has not been cited properly. The corrected reference is provided below.

Reference

7. Tangka FKL, Howard D, Royalty J et al (2015) Cervical cancer screening of underserved women in the United States: results from the National Breast and Cervical Cancer Early Detection Program, 1997–2012. *Cancer Causes Control*. doi:[10.1007/s10552-015-0524-5](https://doi.org/10.1007/s10552-015-0524-5)

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