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Explaining variation across grantees in breast and cervical cancer screening proportions in the NBCCEDP

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Abstract

Purpose—There is substantial variation across the National Breast and Cervical Cancer Early Detection Program (NBCCEDP) grantees in terms of the proportion of the eligible population served by the grantees each year (hereafter referred to as the screening proportion). In this paper, we assess program- and state-level factors to better understand the reason for this variation in breast and cervical cancer screening proportions across the NBCCEDP grantees.

Methods—We constructed a longitudinal data set, consisting of data from NBCCEDP grantees for each of the three study years (program-years 2006–2007, 2008–2009, and 2009–2010). We performed multivariate analysis to explain the variation in breast and cervical cancer screening proportions across the grantees. The program-level factors studied were the total federal funds received, average cost of screening women by grantee, and the overall organizational structure. The state-level variables included were urban versus rural mix, access to care, and the size of the eligible population.

Results—Of the 48 grantees included in the study, those that serve larger populations, as measured by the size of the population and the percentage of women eligible for services, had lower screening proportions. Higher average cost of service delivery was also associated with lower screening proportions. In addition, grantees whose populations were more concentrated in urban areas had lower screening proportions.

Conclusions—Overall, the average cost of screening, the overall size of the population eligible, and the concentration of population in urban areas all had a negative relationship to the proportion of eligible women screened by NBCCEDP grantees.

Keywords

Economics; Breast; Cervical

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Background

The National Breast and Cervical Cancer Early Detection Program (NBCCEDP) was established by Congress in 1990 to provide low-income, uninsured, and underserved women access to timely breast and cervical cancer screening and diagnostic services. The NBCCEDP is administered by the Centers for Disease Control and Prevention (CDC), and the key goal of the NBCCEDP is to improve outcomes for low-income women by identifying breast and cervical cancers at an early stage when treatments are most effective. With the passage of the Breast and Cervical Cancer Prevention and Treatment Act in 2000, the overall goals of the NBCCEDP were further strengthened. Women diagnosed with cancers through the NBCCEDP became eligible to obtain treatment services through state Medicaid programs [1].

The NBCCEDP provides direct services to uninsured and underinsured women with incomes at or below 250 % of federal poverty level. Women aged 18–64 receive cervical cancer screening (the age of eligibility was increased to 21 years in 2012 to align with updated clinical recommendations), and women aged 40–64 receive breast cancer screening [2–4]. About 11 % of US women were eligible for NBCCEDP cervical cancer screening and about 10 % for breast cancer screening [5, 6]. Since 1991, the NBCCEDP-funded programs in the states, District of Colombia (DC), territories, and tribes have screened more than 4.6 million women, provided more than 11.6 million breast and cervical cancer screening examinations, and diagnosed more than 64,718 breast cancers, 3,576 invasive cervical cancers, and 167,169 premalignant cervical lesions, of which 40 % were high grade (http://www.cdc.gov/cancer/nbccedp/about.htm).

The proportion of the eligible population screened by the grantees has been historically low. Based on NBCCEDP data from selected years during the period from 2010 to 2012, it is estimated that the NBCCEDP screened on average 10.6 % of eligible women for breast cancer and 6.5 % of those eligible for cervical cancer using federal funds [5, 6]. In addition, there was substantial variation across grantees, with screening proportions for NBCCEDP-funded services varying from 1.6 to 52.8 % for breast cancer and 1.5 to 32.7 % for cervical cancer.

To date, no systematic assessment has been performed to understand the large variation in screening proportions across the funded programs. Identifying the factors that impact a grantee's ability to screen women in need will help to improve program operations to serve a larger proportion of eligible women. The Affordable Care Act is increasing access to insurance for millions of women, which provides coverage of breast and cervical cancer screening with no cost sharing. However, about half the states have not expanded Medicaid coverage under the law; therefore, a substantial number of low-income women will still likely be eligible for the screening services provided by the NBCCEDP [7]. In those states with Medicaid expansion, the NBCCEDP grantees will still provide screening services for those ineligible for insurance coverage and play an important role in referring low-income women for insurance coverage and in promoting and coordinating breast and cervical cancer screening and diagnostic services to ensure compliance with guideline recommendations.

In this paper, we assess the importance of program- and state-level factors hypothesized to be associated with variation in screening proportions across the NBCCEDP grantees. The findings from this manuscript can be used to inform policies to improve screening proportions across the grantees.

Methods

We used data from the Current Population Survey Annual Social and Economic Supplement (CPS ASEC) for years 2006–2010 to estimate the number of women eligible for breast and cervical cancer screening through the NBCCEDP at the state level. Because the NBCCEDP only provides cervical cancer screening services to uninsured or underinsured low-income women with a cervix, we adjusted our estimates for hysterectomy status using information from the Behavioral Risk Factor Surveillance System (BRFSS). The number of women screened through the program was abstracted from the clinical data reported directly to CDC [Minimum Data Elements (MDE)] by each NBCCEDP grantee. We used data on the number of women eligible and number of women screened to calculate the proportion of eligible women screened through the NBCCEDP. The complete methods for calculating the screening proportions are described elsewhere [5, 6].

We used grantee- and program-level data collected using the NBCCEDP Cost Assessment Tool (CAT), such as average cost per women screened, to understand the factors that explain the variation in screening proportion across the grantees. We use the CAT which is a standardized web-based instrument designed to collect annual activity-based cost data from the grantees [8, 9]. It was designed to derive cost estimates from a programmatic perspective. A detailed protocol was used to guide the data collection at each site, and to ensure the accuracy of data collected with the CAT, a series of data quality checks were also performed. The CAT collected the proportion of cost spent on cervical versus breast cancer screening activities [8]. We were therefore able to separately derive the average cost per women for breast and cervical cancer screening.

The unit of analysis was the individual grantee rather than the client screened by the grantees as the objective of this study was to assess screening proportion variation across the NBCCEDP grantees. We constructed panel data using the three time periods of data collected for the CAT from each grantee (program-years July 2006–June 2007, July 2008–June 2009, and July 2009–June 2010).

Study sample

We limited our sample to state-level programs and the District of Columbia (henceforth referred to as state programs) because screening proportions were not available for programs administered by tribes and territories (5 US territories and 11 American Indian/Alaska Native tribes). We also excluded state-level observations in which expenditures reported by the grantees in the CAT differed from funding levels reported to CDC by more than 10 % (*n* = 2 program). Finally, we excluded observations from one state which uses eligibility criteria that are dissimilar to the rest of the sample. The NBCCEDP funds 68 programs, and our final sample included 48 programs (144 program-year observations).

Variable specification

Dependent variable

The NBCCEDP proportion of women screened for breast and cervical cancer (for the same years as cost data above) were the dependent variables in this analysis. The screening proportion was defined as the number of women screened by each grantee using NBCCEDP funds divided by the number of women eligible for the program. The number of women screened was based on receipt of a NBCCEDP-funded cancer screening test within a recommended screening interval: mammogram within 2 years for breast screening and Papanicolaou (Pap) test within 3 years for cervical screening. These screening proportions excluded women who were screened by the grantees using other funding sources. The cohort of women used to derive the screening proportions were those eligible for the NBCCEDP if they met the specified age range (40–64 for breast cancer screening; 18–64 for cervical cancer screening); were uninsured; and had income at or less than 250 % of the federal poverty level (FPL). Some grantees implemented lower income thresholds for program eligibility. Overall, 31 grantees established income eligibility criteria at 250 % FPL, 17 at 200 %, two at 225 %, and one at 185 %.

Explanatory variables

The explanatory variables in this analysis include a set of program-specific variables and state-level factors that may influence the screening proportions. Program-specific variables were largely based on 3 years of cost data collected from the NBCCEDP grantees that received funding during the 2006–2010 fiscal years. Separate cost estimates were obtained for each time period, and the cost information was analyzed separately for breast and cervical cancer screens. The data were collected via the CAT which was developed for an economic evaluation of the NBCCEDP.

Program-specific variables include the average cost per women served, a measure of programmatic focus (proportion breast versus cervical cancer screens) and binary variables for screening delivery structure (centralized, decentralized, and mixed programs). We calculated the average cost per woman screened for breast and cervical cancer, respectively. This included the cost of screening and diagnostic evaluation and cost of program operations using cost data from the CAT and information on the number of women screened using federal funds from the MDE. Expenditures were divided into breast cancer-specific and cervical cancer-specific costs using relative allocations for each program activity reported in the CAT. We selected average cost per women screened and not total funding as an explanatory variable because past research has shown that NBCCEDP grantees have significant fixed cost related to program operations that are not directly related to the volume of women screened [10]. Because the screening proportions include only women who were screened using federal funds, these expenditures were limited to federal dollars by applying the percentage of total program funding that comes from the NBCCEDP. The average cost for each program-year observation was calculated by dividing federal expenditures allocated to breast and cervical cancer tests by the number of women screened for that cancer site. Average costs were analyzed on a log scale because of the heavily right-skewed nature of the data. The proportion of women with breast and cervical cancer screens

were calculated based on information from the MDE (confirmed based on screens reported in the CAT). The number of women eligible for the NBCCEDP was obtained from CPS ASEC; this variable was included to assess whether the proportional volume of one type of cancer screening versus the other impacted the screening proportions achieved. Binary variables (three dummies for each type of structure) that indicate program screening delivery structure were constructed based on a series of self-reported indicators of program operations reported by the grantees in the CAT. Centralized programs hire their own staff and directly administer screening services, whereas decentralized programs contract out these services. Grantees with a mixed program structure share qualities from both of these classifications. We included this variable to determine whether the screening delivery structure had a significant influence on grantees' ability to reach the eligible population.

Several state-level factors that were hypothesized to affect the grantee's ability to reach the eligible population were also included. First, the number of women in the specified age range and the fraction of this population that was eligible for the NBCCEDP were identified from the same data used to calculate the screening proportions [5, 6]. Second, the percentage of the population residing in urban areas was estimated using data from the Current Population Survey [11]. The proportion of women who were up to date with current recommendations for mammography (had test in the last 2 years) and Pap tests (had test in the last 3 years) was calculated using data from the BRFSS after applying appropriate exclusions (for instance, pregnant women and those who have undergone hysterectomies) [12]. The percentage of women with low access to medical care was estimated using the county-level Primary Care Health Professional Shortage Area designation from the Department of Health and Human Services. These data were obtained from the Area Resource File and were aggregated to the state level using county populations from the US Census as weights [13, 14]. We also included a time trend (year dummies) to control for any temporal factors that may affect the screening rates.

Statistical analysis

We analyzed NBCCEDP screening proportions using a random effects model. This specification was selected to account for correlation as we have included 3 years of data for each grantee. We analyzed breast and cervical cancer screening rates in separate regressions, using only independent variables that were relevant to that cancer site. The random effects regression was performed using Stata 12 [15]. We report the coefficient values, the confidence interval, and the *p* value.

Results

Table 1 presents the summary statistics for the dependent and explanatory variables. The mean screening proportions reported for the 2006–2010 period were 19.9 % (range = 2.2–55.3 %) and 13.9 % (range = 2.2–44.6 %) for breast and cervical cancer screening, respectively. The average federal cost for delivering breast cancer screening was $316.43, and the average federal cost for cervical cancer screening was $196.70. Overall, 57.6 % of the women were screened for breast cancer, while 42.4 % were screened for cervical cancer. About half the programs were of mixed structure and another third were decentralized. In

general, there were wide variations across the state-level factors among the grantees (Table 1). The proportion of women meeting program eligibility criteria for breast cancer screening ranged from 1.8 to 16.3 %, and for cervical cancer screening, the range was from 2.5 to 17.6 %.

Tables 2 and 3 provide the results of the random effects regression to explain variation in breast and cervical cancer screening proportions, respectively. Overall, the models were able to explain about half of the variation in screening proportions for breast cancer ($R^2 = 0.49$) and about a third of the variation in screening proportions for cervical cancer ($R^2 = 0.37$). The program- and state-level variables that significantly impacted screening proportions were consistent across both models. Among the program-level variables, we found that average cost was significant and had a negative correlation with both breast and cervical cancer screening proportions. The other program variables (proportion of breast versus cervical screens and screening delivery structure) were not significant predictors of screening proportions. Among the state-level factors, the size of the state population, percentage of women eligible for the program, and the percentage of the population that resides in an urban area had a significantly negative effect on the screening proportions. State-specific measures of the proportion of women up to date with screening and the indicator for low access to care did not explain variation in screening. We also did not find a significant time trend for screening proportions over the time period analyzed.

In terms of magnitude, the results indicate that a 10 % increase in average cost was associated with a 0.49 % point decline [$-5.13 \times \log (1.10) = -0.49$ %] in screening proportions for breast cancer screening and a slightly lower decline of 0.41 [$-4.27 \times \log (1.10) = -0.41$] for cervical cancer screening. On the other hand, a 1 % point increase in the proportion of eligible women, conditional on the total number of women, was associated with lower screening proportions: by 1.68 and 0.81 % points for breast and cervical cancer screening, respectively. A 1 % point increase in the population residing in urban areas was associated with decreases in the screening proportion by 0.25 % points for breast cancer screens and about 0.17 % points for cervical cancer screens.

Discussion

The analysis of the factors impacting breast and cervical cancer screening proportions indicates that at least some of the variation among the grantees can be explained by program- and state-level characteristics included in the multivariate regressions performed. Most notably, grantees that serve larger populations, as measured by the size of the population and the percentage of women eligible for NBCCEDP services, tend to have lower screening proportions. Grantees whose populations were more concentrated in urban areas also tend to have lower screening proportions. In addition, higher average cost of women screened was associated with lower screening proportions.

Overall, volume of eligible women is the main driver of the differences seen in screening proportions across the states. Average cost of screening provision, which includes both clinical and programmatic cost, is also a factor. Recent economic analyses of the NBCCEDP have shown that substantial economies of scale exist in the program operations, and thus,

programs that serve larger populations tend to have lower average cost, that is, cost per women screened decreases as program size increases [10, 16]. Therefore, additional efficiencies could potentially be achieved if grantees collaborate on activities with substantial fixed costs (for example, database development/management or creation of patient educational materials). This could decrease the average cost of screening and in turn result in the ability to screen more women and thereby increase the proportion of eligible women served. Lower average cost will increase this proportion, but it will only have a modest impact; a 10 % decrease in cost will only result in about a half percentage point increase in the screening proportion. Regarding the finding of lower screening proportions among states with high concentrations of residents in urban areas, it is conceivable that hard-to-reach populations, defined as those with low education, language barriers, and other factors associated with low socioeconomic status, reside in urban areas. Grantees may require additional resources to identify and inform hard-to-reach individuals using targeted education, outreach, and patient navigation services. It is also conceivable that constraints on program allocations that require or encourage funding to be spread throughout the state limit the ability of grantees to reach more women in densely populated urban areas. Additional research is needed to further explore this issue.

The analysis presented in this study benefited from detailed, activity-based cost data that were used to ascertain average cost per women served. In addition, a broad range of both program- and state-level characteristics were included in the multivariate assessment. Among the study limitations, the unit of analysis for this study was the state (and included DC) and not the grantee, as standardized estimates of eligible populations (used in calculating the screening proportions) were not available for NBCCEDP grantees that are tribal organizations and US territories. We also did not consider spatial structure including whether there were differences by regional clusters within states. In addition, we only included federal cost in this analysis and the screening proportions were restricted to women reached using federal funds. State programs may differ in how they use available non-federal funds to reach their eligible population (for example, focus on urban versus rural areas), and therefore, assessment including all funds and screens in a given state may result in different findings from those presented in this study. Several NBCCEDP grantees pool funds from multiple sources to support their activities, and therefore, a direct correlation between program activity and funding stream may not always be possible [16]. Furthermore, we did not adjust for cost of providing services across states. Cost of living varies from state to state and could have an impact on the number of women screened. The study period was also during a major recession in the USA, and therefore, the pool of women eligible for NBCCEDP may have been much larger than generally expected. Also, we did include the average cost per women but not the details on the distribution of the cost which could differ across the programs due to variation in the cost of the tests and other services provided (such as patient navigation).

Overall, the average cost of screening, the overall size of the population eligible to be screened, and the concentration of population in urban areas all had a negative relationship to the proportion of eligible women screened by NBCCEDP grantees. These findings may be used to inform NBCCEDP grantees and help them identify ways to potentially implement program activities, reduce the cost of screening per woman, or make resource allocation

decisions that could result in serving a larger proportion of the NBCCEDP eligible population.

Acknowledgments

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Table 1

Summary statistics for program-and state-level variables (*n* = 144 program-years)

	Mean	SD	Minimum	Maximum
Screening proportion—breast (%)	19.94	12.03	2.22	55.29
Screening proportion—cervical (%)	13.89	10.42	2.23	44.58
Program-level factors				
Federal average cost—breast ($)[a]	316.43	155.13	75.36	1,089.63
Federal average cost—cervical ($)[a]	196.70	145.68	41.95	1,509.93
Women served—breast (%)	57.61	8.70	33.65	79.33
Women served—cervical (%)	42.39	8.70	20.67	66.35
Screening program structure				
Centralized (%)	18.75			
Decentralized (%)	34.72	–	–	–
Mixed (%)	46.53	–	–	–
State-level factors				
Female state population 40–64 (millions)	1.02	1.09	0.08	5.80
Female state population 18–64 (millions)	1.91	2.09	0.16	11.36
Women aged 40–64 eligible for NBCCEDP	7.56	2.99	1.80	16.30
Women aged 18–64 eligible for NBCCEDP (%)	8.87	2.95	2.50	17.60
Population residing in urban area (%)[b]	73.94	18.42	27.33	100.00
Up to date with mammography recommendations (%)	74.17	5.03	61.28	84.88
Up to date with Pap test recommendations (%)	82.28	3.70	71.44	89.81
Low access to care (%)[b]	42.07	27.82	0.00	100.00
Time trend	2.65	1.22	1.00	4.00

[a] Average cost per woman served

[b] The 100 % reported in these categories are due to the inclusion of District of Columbia in the sample

Table 2

Random effects regression model results for breast cancer screening proportion

	Coefficient	Lower CI	Upper CI	p Value
Log of federal average cost[a]	−5.13	−8.32	−1.93	0.002 ***
Women served—breast (%)	−0.01	−0.13	0.12	0.931
Screening program structure (compared to centralized)				
Decentralized	2.73	−4.45	9.91	0.456
Mixed	4.73	−2.06	11.52	0.172
Female state population 40–64 (millions)	−3.41	−6.09	−0.72	0.013 **
Women aged 40–64 eligible for NBCCEDP (%)	−1.68	−2.22	−1.14	0.000 ***
Population residing in urban area (%)	−0.25	−0.40	−0.09	0.002 ***
Mammogram compliance (%)	0.00	−0.33	0.33	0.985
Low access to care (%)	0.02	−0.07	0.10	0.704
Time trend	0.20	−0.30	0.70	0.433
Constant	79.53	43.30	115.76	0.000 ***
R squared	0.493			

***
p value <0.01

**
p value <0.05

[a]Average cost per woman served

Table 3

Random effects regression model results for cervical cancer screening proportion

	Coefficient	Lower CI	Upper CI	*p* Value
Log of federal average cost[a]	–4.27	–6.22	–2.31	0.000 ***
Women served—cervical (%)	0.09	–0.02	0.19	0.100
Screening program structure (compared to centralized)				
Decentralized	–1.70	–8.40	5.00	0.619
Mixed	–0.59	–6.96	5.79	0.857
Female state population 18–64 (millions)	–1.54	–2.86	–0.22	0.023 **
Women aged 18–64 eligible for NBCCEDP (%)	–0.81	–1.37	–0.25	0.004 ***
Population residing in urban area (%)	–0.17	–0.31	–0.02	0.022 **
Pap smear compliance (%)	0.07	–0.22	0.37	0.618
Low access to care (%)	0.01	–0.07	0.09	0.761
Time trend	0.01	–0.45	0.47	0.976
Constant	48.84	19.25	78.44	0.001 ***
R squared	0.368			

***
p value <0.01

**
p value <0.05

[a]Average cost per woman served