Impact of the National Breast and Cervical Cancer Early Detection Program on Cervical Cancer Mortality Among Uninsured Low-Income Women in the U.S., 1991–2007

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Background: The benefits of the National Breast and Cervical Cancer Early Detection Program (NBCCEDP) on cervical cancer screening for participating uninsured low-income women have never been measured.

Purpose: To estimate the benefits in life-years (LYs) gained; quality-adjusted life-years (QALYs) gained; and deaths averted.

Methods: A cervical cancer simulation model was constructed based on an existing cohort model. The model was applied to NBCCEDP participants aged 18–64 years. Screening habits for uninsured low-income women were estimated using National Health Interview Survey data from 1990 to 2005 and NBCCEDP data from 1991 to 2007. The study was conducted during 2011–2012 and covered all 68 NBCCEDP grantees in 50 states, the District of Columbia, five U.S. territories, and 12 tribal organizations. Separate simulations were performed for the following three scenarios: (1) women who received NBCCEDP (Program) screening; (2) women who received screening without the program (No Program); and (3) women who received no screening (No Screening).

Results: Among 1.8 million women screened in 1991–2007, the Program added 10,369 LYs gained compared to No Program, and 101,509 LYs gained compared to No Screening. The Program prevented 325 women from dying of cervical cancer relative to No Program, and 3,829 relative to No Screening. During this time period, the Program accounted for 15,589 QALYs gained when compared with No Program, and 121,529 QALYs gained when compared with No Screening.

Conclusions: These estimates suggest that NBCCEDP cervical cancer screening has reduced mortality among medically underserved low-income women who participated in the program.
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Introduction

In the U.S., cervical cancer incidence and mortality have declined significantly since the widespread introduction of the Pap test in the 1950s.[1–3] These reductions have been attributed to many factors, including adherence to early detection and treatment,[1,4] as well as affordability and acceptability of the screening test.[5,6]

Although progress has been made in reducing morbidity and mortality, the benefits are unequally distributed among all women. Past studies have demonstrated that poor, uninsured, and underinsured women receive less screening than affluent women.[7–9] To reduce disparities in cervical cancer incidence and mortality, the U.S. Congress passed the Breast and Cervical Cancer Mortality Prevention Act (Public Law 101-354) in 1990. The law authorized the establishment of the National Breast and Cervical Cancer Early Detection Program

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(NBCCEDP) to reach underserved women.[10] The program is administered by the CDC in all 50 states, District of Columbia, tribal organizations, and U.S. territories to provide low-income, uninsured women aged 18–64 years with cancer screening, diagnosis, and referral to treatment. A detailed description of the program has been presented elsewhere.[10] Since its inception in 1991, more than 2.9 million women have been screened for cervical cancer and 3,206 invasive cancers have been detected.[10]

These accomplishments have not been quantified in terms of gain in life expectancy for uninsured low-income women participating in the NBCCEDP. Therefore, the purpose of this study was to (1) estimate age-specific number of life-years (LYs) gained with NBCCEDP cervical cancer screening (Program) compared with screening in the absence of the program (No Program) and in the absence of screening (No Screening); (2) estimate the age-specific number of cervical cancer deaths prevented in the Program compared with No Program and No Screening; and (3) estimate the quality-adjusted life years (QALYs) gained in the Program versus No Program and No Screening.

Methods

The impact of the Program on life expectancy in uninsured low-income women was estimated using a previously published and validated model (the "Duke" model),[11,12] 1991–2007 data from the NBCCEDP surveillance database, and other public data sets. A brief summary of the model is provided below, and further details are provided in the Appendix and elsewhere.[11,12] The model is a time-dependent Markov state transition model with 20 main states. It assumes all cervical cancers develop from human papilloma virus (HPV) infection[11]; the disease may progress to squamous intraepithelial lesions (SIL) and to invasive cancer.[11] The parameters used in the model were further calibrated to match HPV; low-grade squamous intraepithelial lesions (LSILs); high-grade squamous intraepithelial lesions (HSILs); and cervical cancer prevalence in available cross-sectional data. Key inputs used in the model are presented in Appendix A. Model extensions were programmed in TreeAge Pro 2009 Suite, version 1.0.2 (TreeAge Software Inc., Williamstown MA). The study was conducted during 2011–2012.

All assumptions and parameter inputs of the original Duke model were adopted, except for the cohort starting distribution. The original model follows a cohort of healthy women from age 12 years onward. This study modeled outcomes for NBCCEDP women aged 18–64 years who were diagnosed with HPV, LSIL, HSIL, and cervical cancer following program-administered screenings. Estimates for the distribution of detected pre-cancerous or cancerous stages for each age were derived from the NBCCEDP database for women who were subsequently diagnosed in a pre-cancerous (HPV, LSIL, or HSIL) or cancerous stage. These women were stratified according to their age at diagnosis. The database also contained a few unclassified abnormal Pap results. Diagnostic results were both cervical intraepithelial neoplasia (CIN)-classified and SIL-classified. Some cancers in the database were staged as American Joint Committee on Cancer stage I–IV or as Surveillance, Epidemiology, and End Results Summary Stage (local, regional, distant, or unknown).[13,14] The following assumptions were made: (1) unclassified abnormal Pap results were assumed to have HPV as the underlying cause; (2) CIN-1 classified lesions were considered LSIL; (3) CIN-2/CIN-3 classified lesions were considered HSIL; (4) local tumors were classified as stage I cervical cancer; (5) regional tumors were randomly assigned to cervical cancer stage II or stage III; (6) distant tumors were assigned to cervical cancer stage IV; and (7) unstaged tumors were split among all four cancer stages, using the relative proportion of each cancer stage as weights.

The NBCCEDP provides both screening and diagnostic services. Theoretically, symptomatic women should exhibit worse natural history stage distribution than their asymptomatic counterparts. Women were classified as symptomatic if they had a first NBCCEDP-recorded procedure that was not a Pap test; the asymptomatic population consisted of all other women. In the analysis, the two groups were merged because very little difference was found between their disease stage prevalence (Appendix B).

Based on NHIS data from 1990 to 2005, more than 90% of uninsured women received at least one Pap test by age 40 years. Therefore, the frequency of subsequent screens was modeled rather than time to first screen. Women were grouped into three categories of Pap test behavior: (1) women who almost always got the test (annual screeners); (2) women who skipped some of their tests (biennial screeners); and (3) women who had unpredictable gaps between tests (irregular screeners). Annual, biennial, and irregular screeners were defined to be women who average <1.5 years, 1.5–2.5 years, and >2.5 years between tests. We derived age-dependent probabilities that a woman would receive a Pap test in a given year. Appendix C describes how the proportions of annual, biennial, and irregular screeners were calculated.

The goal of NBCCEDP cervical cancer screening is to detect pre-cancers early and subsequently provide appropriate and timely treatment. Since 2000, internal program analysis has shown an average treatment compliance of 93%.[15] In the model, both early detection and treatment were used to evaluate the impact of NBCCEDP (Appendix D). Women whose test results are inconclusive (atypical squamous cells of undetermined significance [ASCUS] classification) receive a follow-up screening after 6 months. A second abnormal result leads to colposcopy. Colposcopy is also performed for all abnormal screening results. Diagnostic colposcopy is assumed to be 100% sensitive and specific for disease stages at or beyond LSIL. Women diagnosed with cancer generally receive the recommended treatment for the particular cancer stage (treatment is reflected in the cancer mortality probabilities). Women who undergo treatment in HPV, LSIL, or HSIL stages are considered significantly less likely to develop lesions in the future and are subjected to a more rigorous screening schedule.[11,12]

Age-specific other-cause mortality was derived by subtracting cervical cancer from all-cause mortality using 1995 life tables for women.[16]

Using the model, undiscounted LYs were estimated by running the program population through three different

scenarios (Program, No Program counterfactual, and No Screening counterfactual). For each scenario, 47 different cohorts were run—one for each age starting at 18 years and ending at 64 years. In the Program scenario, women entered the simulation in the detected states for each stage, based on the distribution of NBCCEDP pre-cancerous and cancerous stages. In the two counterfactual scenarios, they entered the simulation in the corresponding undetected states. LYs gained were calculated by subtracting the LYs measured under each of the two counterfactuals from the LYs measured in the Program scenario (Appendix D).

The undiscounted QALYs were estimated by adjusting the estimated LYs to account for the quality of life resulting from screening. Utility values used for cervical cancer natural history stages were obtained from published studies.[12,17,18] The values refer to the preference that an individual places on the outcome of the screening intervention. It ranges from 0.0 (equivalent to death) to 1.0 (equivalent to perfect health).[19] For CIN-1 and CIN-2/3, values of 0.97 and 0.93 were used, respectively.[17] In cervical cancer stages, base-case values used were 0.68 for local, 0.56 for regional, and 0.48 for distant.[18] In sensitivity analyses, the values used were 0.60–1.00 for local, 0.40–1.00 for regional, and 0.35–1.00 for distant.

Because patients were enrolled at different starting ages, utilities were assigned for the portion of time they spend in the model only (i.e., from their modeled age of entry in the program to the end of their lives). Patients were only assigned cancer stage utilities for the first 5 years of follow-up.[12] Further, patients were considered cancer survivors if they lived beyond the initial 5 years and received full utility of one for the remainder of their lives. It was assumed that women detected and treated with LSIL and HSIL had decreased quality of life during that year.

The main analysis did not distinguish between women who were asymptomatic versus symptomatic. Therefore, a sensitivity analysis was performed distinguishing between the two groups, assuming that women with symptoms would have undergone diagnostic testing in the absence of the Program. This tends to lower the benefits received by the symptomatic group in the Program versus No Program comparison. However, Program participants do receive additional screenings in subsequent years.

In other sensitivity analyses, the following natural history progression parameters were varied: (1) proportion of HPV infections that progress directly to HSIL; (2) progression rate of HPV that developed into LSIL; (3) regression rate of LSIL to HPV or well state for women aged ≥35 years; (4) progression rate of non-regressing LSILs that move to HSIL at age ≥35 years; (5) progression rate of non-regressing HSIL to stage I cancer; and (6) proportion of HSIL that regresses to LSIL or well state.

Results

From 1991 to 2007, more than two thirds (82.4%) of women screened in the Program were aged between 40 and 64 years. Most (98%) women were diagnosed with a pre-cancerous condition. Among those with cancer, the vast majority (89.3%) were aged between 40 and 64 years (Table 1).

Among 1.8 million women aged 18–64 years screened from 1991 to 2007, an estimated 325 deaths were prevented by the Program relative to the No Program scenario and 3,829 relative to No Screening (Table 2). Participants in the Program gained 10,369 LYs compared with the No Program scenario, and 101,509 LYs when compared with the No Screening scenario (Table 2). Per woman screened, participants in the Program gained 0.006 LYs (or 2.06 days) compared with the No Program scenario and 0.055 LYs (or 20.14 days) compared with the No Screening scenario.

Participants in the Program gained 15,589 QALYs when compared to the No Program scenario, and 121,519 QALYs gained when compared to the No Screening scenario (Table 3). Per woman screened, participants in the Program gained 0.008 QALYs (or 3.09 days) compared with the No Program scenario and 0.066 QALYs (or 24.11 days) compared with the No Screening scenario. The LY and QALY results indicate that in the past 20 years, the NBCCEDP has saved many additional years of life for participating women and has improved the health-related quality of life of these low-income underserved women.

Table 1. Total program participants and number diagnosed with HPV, SIL, or cancer by age group, 1991–2007, *n* (%)

Age group (years)	Total number of program participants in age group	Number of program participants in age group with HPV, SIL, or cancer	Number of program participants with HPV, LSIL, or HSIL	Number of program participants with cancer stage I–IV
18–29	148,006 (8.05)	21,756 (31.47)	21,723 (32.08)	33 (2.31)
30–39	176,546 (9.60)	10,902 (15.77)	10,782 (15.92)	120 (8.42)
40–64	1,515,117 (82.36)	36,482 (52.77)	35,209 (52.00)	1,273 (89.27)
All ages (18–64)	1,839,669 (100.00)	69,140 (100.00)	67,714 (100.00)	1,426 (100.00)

HPV, human papillomavirus infection; HSIL, high-grade squamous intraepithelial lesion; LSIL, low-grade squamous intraepithelial lesion; SIL, squamous intraepithelial lesion

Table 2. Estimated program benefits for cervical cancer screening by age group, 1991–2007

Age group (years)	Days gained per woman, Program versus		LYs gained per woman, Program versus		Total LYs gained, Program versus		Deaths averted, Program versus	
	No Program	No Screening	No Program	No Screening	No Program	No Screening	No Program	No Screening
18–29	8.32	109.19	0.023	0.299	3,376	44,277	67	1,204
30–39	3.83	43.16	0.010	0.118	1,850	20,878	47	720
40–64	1.24	8.76	0.003	0.024	5,144	36,354	210	1,905
All ages (18–64)	2.06	20.14	0.006	0.055	10,369	101,510	325	3,829

LYs, life-years

Sensitivity Analyses

In the one-way sensitivity analyses comparing the Program versus No program scenarios, estimates of days gained per woman were generally not sensitive to changes in disease progression rates (Table 4). However, estimated days gained per woman were slightly sensitive to assumptions about the transition rate from LSIL to HSIL and most sensitive to assumptions about the transition rate from HSIL to stage I cancer.

Outcomes were slightly different for the Program versus No Screening comparison. By varying the proportion of LSIL that regresses to HPV or well state from 0.06 (base-case) to 0.50, the estimated gain in life expectancy decreased from 20.14 to 15.62 days (Table 4). Varying the progression of non-regressing LSIL to HSIL from 0.06 (base-case) to 0.50 increased estimated life expectancy from 20.14 to 36.35 days. The estimates increased substantially from 20.14 to 48.09 days gained when the assumptions about the transition rate from HSIL to Stage 1 cancer was varied from 0.04 (base-case) to 0.20. Similar results were found for gains in quality-adjusted life expectancy. Also, distinguishing between symptomatic and asymptomatic cases lowered the benefits of the program slightly in both scenarios.

Including the potential impact of cancer on quality of life increased the net benefit of the Program (Table 4). For example, using base-case values, the Program increased quality-adjusted life expectancy by 3.09 days compared to No Program, an almost 50% increase in benefit compared to the estimated gains without adjusting for quality of life (2.06 days).

Discussion

This study provides the first quantitative estimate of the effects of the NBCCEDP on cervical cancer mortality measured by LYs gained, QALYs gained, and deaths prevented because of the promotion and provision of cancer screening services to uninsured low-income women throughout the U.S. over the past 20 years. The findings indicate that NBCCEDP may have contributed to reducing cervical cancer mortality in underserved, hard-to-reach low-income women who otherwise may have not received such preventive health services.

Although the estimated benefits measured in terms of deaths averted by the Program appear small, the Program only reaches about 10% of the eligible population.[20] Comparison with other national prevention programs is difficult because of differences in study characteristics, population, and methods. However, Table 5 shows expected improvements in additional LYs per person from selected population-based preventive health

Table 3. Estimated benefits measured in the Program, No Program, and No Screening scenarios, 1991–2007

Age group (years)	QALYs gained for women with positive test results			QALYs gained per woman, Program versus		QALYs (in days) gained per woman, Program versus		Total QALYs gained, Program versus	
	Program	No Program	No Screening	No Program	No Screening	No Program (days)	No Screening (days)	No Program	No Screening
18–64	81.52	81.29	79.76	0.008	0.066	3.09	24.11	15,589	121,519

QALYs, quality-adjusted life-years

Table 4. Sensitivity analyses on the program benefits measured in days gained per woman

	Program versus No Program (days gained per woman)	Program versus No Screening (days gained per woman)	Quality-adjusted: Program versus No Program	Quality-adjusted: Program versus No Screening
Main analysis	2.06	20.14	3.09	24.11
Proportion of HPV to SIL transitions going directly to HSIL				
(base case=0.1)				
0	2.02	19.84	3.04	23.75
0.25	2.11	20.58	3.17	24.66
0.5	2.19	21.32	3.30	25.56
1	2.36	22.79	3.56	27.38
Progression of HPV that develop SIL				
(base case=0.0645=1 − exp.[−0.2/3])				
0	1.98	18.81	2.94	22.36
0.03	2.02	19.54	3.03	23.33
0.14	2.1	20.98	3.17	25.17
0.2	2.12	21.4	3.20	26.29
Regression of LSIL to HPV or well				
(base case over 40=0.0645=1 − exp.[−0.4/6])				
0	2.11	25.81	3.21	31.47
0.03	2.08	22.84	3.16	27.56
0.14	2.02	18.35	3.02	21.77
0.2	2	17.38	2.97	20.54
0.5	1.92	15.62	2.81	18.33
Progression of non-regressing LSILs that move to HSIL				
(base case over 40=0.0567=1-exp.[−0.35/6])				
0	1.87	14.8	2.80	17.30
0.03	2.01	19.09	3.02	22.64
0.14	2.43	27.79	3.63	33.27
0.2	2.6	30.37	3.87	36.37
0.5	3.13	36.35	4.64	43.46
Progression of non-regressive HSIL to Stage I cancer				
(base case=0.0392=1 − exp.[−0.4/10])				
0	0.32	0.96	0.82	0.94
0.08	3.67	31.83	5.20	37.93
0.12	5.09	39.21	7.05	46.53
0.2	7.53	48.09	10.23	56.76

(continued on next page)

Table 4. Sensitivity analyses on the program benefits measured in days gained per woman *(continued)*

	Program versus No Program (days gained per woman)	Program versus No Screening (days gained per woman)	Quality-adjusted: Program versus No Program	Quality-adjusted: Program versus No Screening
Proportion of HSIL that regresses to LSIL or well-state				
(base case=0.0567=1 − exp.[−0.35/6])				
0	2.32	30.63	3.46	37.27
0.03	2.17	24.16	3.26	29.12
0.12	1.81	14.07	2.75	16.65
0.16	1.67	11.64	2.55	13.71
Distinguish between symptomatic and asymptomatic cases	1.97	18.39	2.21	20.78
(base case makes no distinction)				
Change cancer stage utility values	2.06	20.14	2.06	20.14
(base case values by stage: I=0.68, II/III=0.56, IV=0.48)				
No cancer SIL disutility				
(=unadjusted life expectancy)				
Lowest values for utilities	2.06	20.14	3.27	25.34
(I=0.6, II/III=0.4, IV=0.35)				

HPV, human papillomavirus infection; HSIL, high-grade squamous intraepithelial lesion; LSIL, low-grade squamous intraepithelial lesion

services.[21–24] An estimate of 0.0060 LYs saved for women aged 18–64 years is consistent with other estimates of cervical cancer screening beginning at age 20 years (0.0049 LYs) and compares favorably to other preventive health services, such as childhood measles and rubella vaccines (0.008 LY each)[21]; annual guaiac fecal occult blood test for adults aged ≥50 years (0.0080 LYs)[24]; and smoking-cessation advice and assistance (0.0098 LYs).[22]

This study included women aged 18–20 years because the NBCCEDP followed the 2003 U.S. Preventive Services Task Force (USPSTF) recommendation that was current during the years of this study.[25] However, the USPSTF and other professional organizations have published updated recommendations to start screening at age 21 years regardless of sexual history.[26–30] The NBCCEDP has since adopted these recommendations.

In the U.S., access to cancer screening is highly dependent on access to affordable, acceptable medical care. For the past 20 years, the NBCCEDP, through its vast network of public and private healthcare providers, has had a direct role in the healthcare delivery system by providing preventive cancer screening and diagnostics services to uninsured low-income women. The program also provides treatment referral services for those women diagnosed with cancer through the Breast and Cervical Cancer Prevention and Treatment Act of 2000.[31]

In 2003, the IOM recommended that the NBCCEDP reach all eligible women.[32] For 2006, the year the most recent data are available, the NBCCEDP reached about 10% of women eligible for cervical screening.[20] If the number of women reached by the program increases, it is expected that the estimated LYs saved may increase. For example, doubling the number of eligible women reached from 10% to 20% would be expected to double the LYs saved by the program, assuming that women newly served have similar characteristics as previous program participants.

The Patient Protection and Affordable Care Act of 2010 (ACA) will impact insurance coverage rates for NBCCEDP eligible women. The ACA is intended to improve access to preventive health care for all Americans including NBCCEDP-eligible women by reducing financial barriers to preventive health services, through expanded insurance coverage and eliminating cost sharing for these services. It is expected that improvement in these services may increase the number of women screened in the NBCCEDP, which may proportionately increase LYs saved in the program.

Table 5. Life-years saved by selected preventive health services

Intervention	Target population	Life-years saved per person	Data source, year
Quitting cigarette smoking	35-year-olds	0.667–0.833	Wright et al. 1998[21]
Smoking-cessation advice and assistance	≥18-year-olds	0.0098	Maciosek et al. 2010[22]
childhood immunizations	<5-year-olds	0.1233	Maciosek et al. 2010[22]
Measles vaccine	<5-year-olds	0.0080	Wright et al. 1998[21]
Rubella vaccine	<5-year-olds	0.0080	Wright et al. 1998[21]
Influenza immunization	≥50-year-olds	0.0024	Maciosek et al. 2010[22]
Breast cancer screening	≥50-year-old women	0.0045	Maciosek et al. 2010[22]
NBCCEDP–breast cancer screening	Low-income, uninsured women aged 40–64 years	0.0560	Hoerger et al. 2011[23]
Pap smear every year	20-year-old women	0.0049	Wright et al., 1998[21]
NBCCEDP–cervical cancer screening	Low-income, uninsured women aged 18–64 years	0.0060	Authors' estimate
NBCCEDP–cervical cancer screening	Low-income, uninsured women aged 18–29 years	0.0230	Authors' estimate
NBCCEDP–cervical cancer screening	Low-income, uninsured women aged 30–39 years	0.0100	Authors' estimate
NBCCEDP–cervical cancer screening	Low-income, uninsured women aged 40–64 years	0.0030	Authors' estimate
Colorectal cancer screening	≥50-year-olds, FOB	0.0041	Maciosek et al. 2010[22]
Annual guaiac fecal occult blood test	≥50-year-olds	0.0080	Steele et al. 2004[24]
Cholesterol screening	≥50-year-olds	0.0028	Maciosek et al. 2010[22]
Hypertension screening	≥18-year-olds	0.0011	Maciosek et al. 2010[22]

FOBT, fecal occult blood test; NBCCEDP, National Breast and Cervical Cancer Early Detection Program

However, a recent study on the NBCCEDP-eligible population estimated that the ACA will reduce the number of uninsured women by 6.8 million, assuming all states expand Medicaid coverage.[33] The study concluded that 4.5 million women will remain uninsured and eligible for the program after full ACA implementation. However, given uncertainties about the number of states that may expand Medicaid coverage, these estimates may increase.[34]

This study focused on the clinical outcomes (i.e., LYs, QALYs, and deaths prevented) of the NBCCEDP. Modeling only clinical outcomes helps to clearly demonstrate the value of a preventive cancer screening program such as the NBCCEDP. Further, the modeling approach also was designed to address the ultimate goal of the program to prevent morbidity and mortality from cervical cancer without considering costs, an approach similar to other modeling analyses used to develop screening policies in the U.S.[29] Analysis of the cost and cost-effectiveness of cervical cancer screening in the NBCCEDP is expected to be completed in the future.

This study has some limitations. First, the results are based on a well-known validated simulation model rather than clinical trial results or a long-term follow-up study of health outcomes. Second, analysis of QALYs does not include disutility from false-positive test results, particularly in younger women.[29] Third, this study did not distinguish the effects of the use of different screening technologies such as liquid-based cytology (LBC) on the effectiveness of the program in cervical cancer mortality. However, recent studies have reported that there are no important differences between the use of LBC and conventional cytology in terms of their relative sensitivity, specificity, and positive predictive value.[35–37]

Fourth, the analysis includes only the direct effects of the NBCCEDP on cervical cancer survival and does not take into account how the NBCCEDP may help uninsured women gain access to the healthcare system, leading to better care for conditions besides cervical cancer. For instance, the Well-Integrated Screening and

Evaluation for Women Across the Nation (WISEWOMAN) program provides heart disease and stroke screening to women who enter NBCCEDP.[38]

Fifth, the analysis only focuses on the effects of NBCCEDP screening. However, cervical cancer outcomes may be impacted by other public health interventions that reduce or eliminate risk factors such as smoking, HIV infection, and infection with oncogenic HPV.[39–41] These programs are not explicitly modeled in this study. Finally, probabilistic sensitivity analyses were not conducted as recommended by the new International Society for Pharmacoeconomics and Outcomes Research guidelines.[42]

Despite these limitations, the estimates suggest that the NBCCEDP has succeeded in reducing cervical cancer morbidity and mortality among medically underserved, low-income women who received preventive health services through the program. Although the program only reaches about 10% of eligible population, this success has been a result of strong collaboration and sustained commitment from program administrators at the CDC, coordinators at state health departments, health policy makers, and from the Program's public and private partners for the past 20 years. These quantitative estimates of the impact of the NBCCEDP's efforts may provide useful information for public health decision making.

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Appendix

Supplementary data

Supplementary data associated with this article can be found at http://dx.doi.org/10.1016/j.amepre.2014.05.016.