

Medicaid Expansion and Breast Cancer Screening in Appalachia and Non-Appalachia, United States, BRFSS 2003 to 2015

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Abstract

Background: Prior data suggests that breast cancer screening rates are lower among women in the Appalachian region of the United States. This study examined the changes in breast cancer screening before and after the implementation of the Affordable Care Act Medicaid expansion, in Appalachia and non-Appalachia states.

Methods: Data from the Behavioral Risk Factor Surveillance System between 2003 and 2015 were analyzed to evaluate changes in breast cancer screening in the past 2 years among US women aged 50-74 years. Multivariable adjusted logistic regression and generalized estimating equation models were utilized, adjusting for sociodemographic, socioeconomic, and health-care characteristics. Data were analyzed for 2 periods: 2003 to 2009 (pre-expansion) and 2011 to 2015 (post-expansion) comparing Appalachia and non-Appalachia states.

Results: The prevalence for of self-reported breast cancer screening in Appalachia and non-Appalachia states were 83% and 82% ($P < .001$), respectively. In Appalachian states, breast cancer screening was marginally higher in non-expanded versus expanded states in both the pre-expansion (relative risk [RR]: 1.002, 95% confidence interval [CI]: 1.002-1.003) and post-expansion period (RR: 1.001, 95% CI: 1.001-1.002). In non-Appalachian states, screening was lower in non-expanded states versus expanded states in both the pre-expansion (RR: 0.98, 95% CI: 0.97-0.98) and post-expansion period (RR: 0.95, 95% CI: 0.95-0.96). There were modest 3% to 4% declines in breast cancer screening rates in the post-expansion period regardless of expansion and Appalachia status.

Conclusions: Breast cancer screening rates were higher in Appalachia versus non-Appalachia US states and higher in expanded versus nonexpanded non-Appalachia states. There were modest declines in breast cancer screening rates in the post-expansion period regardless of expansion and Appalachia status, suggesting that more work may be needed to reduce administrative, logistical, and structural barriers to breast cancer screening services.

Keywords

mammography, Medicaid expansion, breast cancer screening

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Introduction

Breast cancer is the most commonly diagnosed cancer among women in the United States, with an estimated 252 710 new breast cancer cases and 40 610 deaths expected in 2017.¹ Progress in early detection through mammography and improvements in breast cancer treatment have markedly improved the prognosis for breast cancer, and death rates are now about one-third of the levels in 1990.²⁻⁴ However, these benefits are not distributed equally across the US population.¹ Evidence suggests that Appalachian women experience 7% higher breast cancer mortality compared with non-Appalachian women in the United States, partly due to the higher likelihood of breast cancer being diagnosed at a late stage.^{5,6}

The Appalachian geographic region represents 8% of the US population, an area consisting of 420 contiguous counties spanning 13 states. The National Cancer Institute recognizes the Appalachia region of the United States as a special priority area, given that it represents one of the most economically disadvantaged, and medically underserved regions in the United States.⁷⁻¹⁰ Several factors have been identified that may explain later stage at diagnosis and higher breast cancer mortality observed among women living in the Appalachian regions of the United States,¹¹⁻¹³ including lower socioeconomic status and lack of access to health care,^{9,14,15} lower prevalence of routine mammography, and a lower likelihood to receive recommended treatment for breast cancer.¹⁶⁻¹⁸

In 2010, the Patient Protection and Affordable Care Act (ACA) was passed by the US Congress to increase health insurance coverage and expand access to health-care services for Americans. In 2014, approximately 64% of the US population was covered through private insurance,¹⁹ and this proportion has increased with 6.7 million people newly enrolled in 2014 via the insurance marketplace established under the ACA.²⁰ Although as part of the ACA, states have the option of expanding Medicaid to increase health insurance coverage among low-income and uninsured individuals, participation in the Medicaid expansion provision of the ACA occurred in varying degrees across states.²¹⁻²⁴ To date, 31 states including the District of Columbia have expanded Medicaid to low-income adults (individuals with an annual household income <138% of the federal poverty level) or individuals with qualifying disabilities.²⁵⁻²⁷ In addition to increasing health insurance coverage, ACA also required most health plans to cover preventive health-care services without copays or deductibles for A or B-rated recommendations by the US Preventive Services Task Force (USPSTF). In November 2009, the USPSTF issued new age-based recommendations for mammography screening, recommending routine mammography every 2 years for women ages 50 to 74 years.²⁸

Although the ACA and Medicaid expansion has substantially increased health insurance coverage and improved access to health-care services for previously uninsured and low-income Americans,²⁴ the specific impact of the policy on breast cancer screening is still unclear.²⁹ According to a recent review of the literature,²⁹ the lack of consistency in published

estimates may be due to limited number of existing studies, methodological limitations, and the fact that most studies examined only a short time period post-ACA. Despite the higher proportion of uninsured and low-income women in Appalachia regions of the United States, few studies have directly evaluated the impact of the ACA Medicaid expansion on breast cancer screening behaviors in this region relative to other parts of the US.¹¹⁻¹³ The current study aims to examine changes in breast cancer screening before and after ACA Medicaid expansion comparing Appalachia and non-Appalachia states. Results may highlight the impact of health insurance changes due to the ACA on breast cancer screening rates in a historically under-served region, and highlight areas where additional strategies may be needed to narrow existing health disparities.

Methods

Data Source

Data were obtained from the Centers for Disease Control and Prevention (CDC) Behavioral Risk Factor Surveillance System (BRFSS). The BRFSS is a representative ongoing, state-based system of landline- and cellular-telephone health surveys.^{30,31} The BRFSS uses a multistage sampling design to obtain data on self-reported health-related information from non-institutionalized civilian population aged ≥ 18 years residing in all 50 states, including the District of Columbia and the 3 US territories (Guam, Puerto Rico, and the US Virgin Islands).³⁰ The BRFSS collected data on demographic characteristics, health-related behaviors, chronic health conditions, health-care access, and the use of preventive health services that are associated with the leading causes of death and disability in the United States.^{30,31} Each year of the BRFSS surveys includes 3 parts: (1) the core component, (2) optional modules, and (3) state-added questions. Since 2000, questions regarding women's health, including history of mammography visits, were asked in even years in all states as part of the BRFSS fixed core questionnaire.

The current study utilizes data for the years 2003 through 2015, and analysis was performed in 2017. As the BRFSS database is a publicly available and deidentified data source, this study was considered exempt by the institutional review board at the University of Kentucky.

Study Variables

Outcome. The primary outcome in this study was self-reported mammography screening received in the past 2 years. According to USPSTF recommendations, women aged 50 to 74 years are considered up-to-date if they reported receipt of a mammogram in the previous 2 years.²⁸ Respondents who refused to answer, had a missing response, or answered "don't know/not sure" were excluded from the analyses.

Main predictors. The independent variables of interest were Appalachia status and state-level Medicaid expansion status. States were defined as Appalachia or non-Appalachia based on

the Appalachian Regional Development Act of 1965.³² The Appalachian region includes all of West Virginia and parts of 12 other states including Alabama, Georgia, Kentucky, Maryland, Mississippi, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, and Virginia.³² Medicaid expansion was defined in 2 time periods: pre-expansion (2003-2009) and post-expansion (2011-2015). By the end of the study period of December 31, 2015, a total of 31 states and jurisdictions had implemented the expansion of Medicaid, while 21 states did not implement the policy. The 25 expanded non-Appalachian states and jurisdictions are as follows: Alaska, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, District of Columbia, Hawaii, Illinois, Indiana, Iowa, Massachusetts, Michigan, Minnesota, Nevada, New Hampshire, New Jersey, New Mexico, North Dakota, Oregon, Rhode Island, Vermont, US Virgin Islands, and Washington. Among the 13 Appalachia states, 6 states had expanded Medicaid: West Virginia, Kentucky, Maryland, New York, Ohio, and Pennsylvania.

Study covariates. These included income level (categorized as <\$10 000, \$10 000-\$20 000, \$20 000-\$50 000, and ≥\$50 000), respondents' age (categorized as 50-59, 60-69, and 70-74 years), race/ethnicity (white, black, Hispanic, other race), education level (<high school, high school graduate, some college, or ≥college), marital status (married, divorced/widowed/separated, and never married/member of an unmarried couple), and employment status (employed/self-employed, out of work, homemaker, student, retired, or unable to work). Additionally, having a usual health-care provider (at least one provider vs no provider) and having health-care coverage (yes or no) were included. Health coverage includes private insurance, prepaid, and government plans.

Statistical Analysis

Descriptive analyses were conducted using χ^2 tests to compare sociodemographic, socioeconomic, and health-care variables by Appalachia status over the study period. Due to the implementation of the ACA Medicaid expansion in 2010, calendar year 2010 was considered as the washout period. To determine whether there were differences in mammography screening between expanded and nonexpanded states across the study periods, multivariable logistic regression models with generalized estimating equations were used to interpret odds ratios as relative risks after adjusting for age-group, race/ethnicity, annual household income, education, and employment. Subgroup analysis for age groups and among women with annual household income ≤\$20 000 was also conducted. Analyses were weighted using appropriate survey procedures to account for the complex sample survey design. Results were presented as risk ratios and 95% confidence intervals (CIs), and *P* values of <.05 were considered statistically significant. All analyses were conducted using SAS 9.4 (SAS Institute, Cary, North Carolina).

Results

A total of 1 112 972 female participants were included in this analysis: 808 700 (73%) in non-Appalachia states and 304 272 (27%) in Appalachia states (Table 1). Table 1 shows the baseline characteristics of the study participants overall and by Appalachia status. Overall, the majority of participants were white (82%), about 60% had some college degree or higher, 39% had an annual household income of greater than \$50 000, and 91% had health insurance coverage. Compared to the non-Appalachia states, participants in Appalachia states were more likely to be black (16% vs 6%), have less than a high school education (12% vs 8%), have an average annual household income of <\$10 000 (8% vs 6%), and more likely to have no health insurance coverage (9% vs 8%).

Table 2 presents the prevalence of mammography screening in the past two years by socio-demographic, socio-economic and healthcare access variables.

Overall, 82% of study participants had received a mammogram in the past 2 years, 83% in Appalachia states and 82% in non-Appalachia states. In non-Appalachia states, mammography screening was higher in expanded (84%) versus nonexpanded (81%) states overall, regardless of sociodemographic characteristics. For instance, among women ages 50 to 59, screening prevalence was 83% in expanded states compared with 79% in nonexpanded states. In addition, screening was higher among whites (84% vs 81%), and Hispanics (84% vs 79%) in expanded versus nonexpanded states. Screening was lowest among women with no regular health-care provider in both expanded (55%) and non-expanded (54%) non-Appalachia states and highest among those with annual household income >\$50 000. In Appalachia states, there were only modest differences in screening prevalence between expanded and non-expanded states. For instance, 82% of women ages 50 to 59 years were screened in expanded Appalachian states, compared with 83% in non-expanded Appalachian states. Similar to non-Appalachia states, screening was highest among women with annual household income >\$50 000 and lowest among women with no regular health-care provider.

As shown in Table 3, screening was marginally higher in Appalachia non-expanded versus expanded states in the pre-expansion (2003-2009; relative risk [RR]: 1.002, 95% CI: 1.002-1.003) and postexpansion periods (2011-2015; RR: 1.001, 95% CI: 1.001-1.002) after adjusting for study covariates.

In non-Appalachia states, screening was lower in non-expanded states versus expanded states in pre-expansion (RR: 0.978, 95% CI: 0.978-0.979) and postexpansion periods (RR: 0.958, 95% CI: 0.955-0.959). Stronger associations were observed in the 50-59 years and 60-69 years age groups (Table 3). Among expanded states, there was 5% lower screening (RR: 0.956, 95% CI: 0.949-0.957) in the post versus pre-expansion period, while non-expanded states had 3% lower screening (RR: 0.970, 95% CI: 0.969-0.978) in the post-expansion versus pre-expansion period (Table 4).

In subgroup analysis by age group and household income ≤\$20 000 (Table 4), there was a 3% decline in screening

Table 1. Baseline Characteristics of Study Population by Non-Appalachian and Appalachian States Study, BRFSS 2003 to 2015.^a

Study Characteristics	Total (N = 1 112 972)	Non-Appalachian (39 States; n = 808 700)	Appalachia (13 States; n = 304 272)	P Value
Sociodemographics				
Age (years)				
50-59	494 433 (43.14)	361 408 (35.67)	133 025 (32.54)	<.0001
60-69	442 250 (40.77)	319 808 (32.9)	122 442 (31.55)	
70-74	176 289 (16.07)	386 707 (31.41)	139 531 (35.9)	
Race				
White	909 798 (82.09)	670 643 (83.75)	239 155 (79.7)	<.0001
Black	94 905 (8.86)	46 669 (5.86)	48 236 (16.0)	
Hispanic	48 703 (4.51)	43 225 (5.32)	5478 (1.77)	
Other race	49 646 (4.53)	41 591 (5.04)	8055 (2.51)	
Socioeconomic status				
Education				
<High school	102 473 (8.65)	63 887 (7.48)	38 586 (11.80)	<.0001
High school graduate	357 236 (31.57)	248 265 (30.08)	108 971 (35.56)	
Some college or higher	650 458 (59.77)	494 462 (62.43)	155 996 (52.63)	
Income level				
<\$10 000	60 865 (6.28)	40 738 (5.87)	20 127 (7.81)	<.0001
\$10 000-<\$20 000	145 238 (15.15)	98 677 (16.0)	46 571 (14.01)	
\$20 000-<\$50 000	375 324 (39.07)	276 858 (41.7)	98 466 (40.87)	
≥50 000	357 676 (39.49)	272 688 (36.4)	85 008 (31.0)	
Employment				
Employed	423 881 (37.79)	317 535 (38.97)	106 346 (34.64)	<.0001
Self-employed	77 778 (6.94)	61 787 (7.60)	15 991 (5.18)	
Unemployed	47 178 (4.60)	34 529 (4.62)	12 649 (4.53)	
Student/homemaker/retired	452 968 (40.64)	323 448 (39.97)	129 520 (42.46)	
Unable to work	107 396 (10.01)	68 567 (8.82)	38 829 (13.17)	
Marital status				
Married	595 763 (53.7)	437 974 (54.33)	157 789 (52.0)	<.0001
Divorced/widowed/separated	428 150 (38.27)	304 807 (37.50)	123 343 (40.32)	
Never married/unmarried couple	84 359 (8.03)	62 420 (8.16)	21 939 (7.66)	
Health-care access				
Health-care coverage ^b				
Yes	1 015 004 (91.38)	739 064 (91.60)	275 940 (90.80)	<.0001
No	96 274 (8.62)	68 450 (8.40)	27 824 (9.20)	
Health-care providers ^c				
At least one	1 022 562 (92.22)	739 552 (91.84)	283 010 (93.23)	<.0001
No	87 852 (7.78)	67 132 (8.16)	20 720 (6.76)	

Abbreviation: BRFSS, Behavioral Risk Factor Surveillance System.

^aValues in parenthesis denote row percentage. Appalachia states include Alabama, Georgia, Kentucky, Maryland, Mississippi, New York, Ohio, North Carolina, Pennsylvania, South Carolina, Tennessee, Virginia, and West Virginia.

^bHealth-care coverage is defined as having any kind of health-care coverage, including health insurance, prepaid plans such as HMOs, or government plans such as Medicare.

^cHealth-care providers are defined as personal doctor or health-care provider.

post- versus pre-expansion (RR: 0.972, 95% CI: 0.969-0.973) in Appalachia, and in non-Appalachia, there was a 5% (RR: 0.956, 95% CI: 0.949-0.957) and 3% (RR: 0.978, 95% CI: 0.969-0.978) decline post- versus pre-expansion in expanded states and nonexpanded states, respectively. Similar declines were observed among low-income participants (annual household income ≤\$20 000).

Discussion

In a large nationally representative study population of women aged 50-74 years in Appalachia and non-Appalachia US states,

this study examined the impact of ACA Medicaid expansion on breast cancer screening pre- and post-expansion. Results showed that 83% of women in Appalachia states self-reported breast cancer screening in the past 2 years, compared with 82% of women in non-Appalachia states. Overall in Appalachia states, there were negligible differences in screening prevalence comparing expanded and non-expanded states; however, in non-Appalachia states, screening prevalence was significantly higher in expanded compared with non-expanded states. In adjusted models, screening in Appalachia states was marginally higher in non-expanded states compared with expanded states in both pre- and post-expansion periods.

Table 2. Breast Cancer Screening in Appalachian Versus Non-Appalachian States by Expansion Status Among Women Aged 50 to 74 Years During Study Period, BRFSS 2003 to 2015.^a

Characteristics	Breast Cancer Screening ^b					
	Non-Appalachian (39 States)			Appalachian (13 States)		
	Nonexpanded (14)	Expanded (25)	P Value	Nonexpanded (7)	Expanded (6)	P Value
Overall	80.87	84.23		83.81	83.48	
Sociodemographics						
Age (years)						
50-59	58 775 (79.41)	93 977 (82.96)	<.0001	32 819 (82.80)	26 187 (82.33)	<.0001
60-69	55 728 (81.75)	85 751 (85.20)		31 593 (84.14)	24 100 (84.41)	
70-74	23 392 (82.39)	32 834 (85.18)		12 744 (85.45)	9267 (84.25)	
Race						
White	118 281 (80.87)	173 003 (84.3)	<.0001	57 111 (83.22)	50 158 (83.02)	<.0001
Black	7822 (85.93)	13 226 (86.99)		16 231 (86.44)	6140 (88.39)	
Hispanic	5848 (79.55)	11 778 (83.86)		1091 (83.27)	1265 (85.20)	
Other race	5105 (75.71)	12 769 (81.42)		1928 (79.38)	1408 (78.59)	
Socioeconomic status						
Income level						
<\$10 000	6117 (70.63)	8737 (74.47)	<.0001	4744 (75.16)	2927 (74.31)	<.0001
\$10 000-<\$20 000	16 278 (72.31)	20 934 (75.77)		11 247 (76.62)	7355 (74.80)	
\$20 000-<\$50 000	49 597 (79.81)	68 434 (82.59)		25 133 (84.03)	19 749 (82.85)	
≥\$50 000	45 530 (86.23)	83 921 (88.54)		21 999 (89.27)	20 255 (88.29)	
Education						
<High school	10 263 (74.14)	14 057 (79.54)	<.0001	9978 (77.42)	5151 (77.58)	<.0001
High school graduate	44 915 (79.44)	59 683 (82.76)		25 934 (82.67)	21 812 (82.21)	
Some college or higher	82 527 (82.52)	138 531 (85.3)		41 134 (86.11)	32 508 (85.27)	
Employment						
Employed	53 780 (82.07)	87 192 (85.56)	<.0001	26 443 (85.65)	23 190 (85.39)	<.0001
Self-employed	9557 (74.49)	15 209 (79.49)		3775 (79.34)	3096 (79.22)	
Unemployed	4252 (69.89)	8494 (76.01)		2774 (73.77)	2076 (75.76)	
Student/homemaker/retired	58 947 (83.40)	85 670 (86.39)		34 208 (85.87)	25 101 (85.08)	
Unable to work	11 052 (74.34)	15 593 (76.91)		9817 (78.09)	5966 (76.03)	
Health-care access						
Health-care coverage						
Yes	128 764 (83.14)	202 318 (85.94)	<.0001	71 668 (86.03)	56 402 (85.19)	<.0001
No	8943 (57.75)	9984 (59.69)		5361 (62.39)	3074 (60.89)	
Health-care providers						
At least one	130 272 (83.20)	203 028 (86.25)	<.0001	73 389 (85.60)	57 604 (84.97)	<.0001
No	7406 (53.60)	9268 (55.29)		3651 (58.65)	1865 (53.57)	

Abbreviations: ACA, Affordable Care Act; BRFSS, Behavioral Risk Factor Surveillance System.

^aN = 582 381. Expanded states include AR, AZ, CA, CO, CT, DE, HI, IA, IL, KY, MD, MA, MI, MN, NV, NH, NJ, NM, NY, ND, OH, OR, PA, RI, VT, WA, WV, and DC which expanded Medicaid under the ACA between 2010 and 2015. Nonexpanded states did not expand Medicaid under the ACA till the end of 2015.

^bBreast cancer screening is defined as women respondents aged 50 to 74 who have had a mammogram in the past 2 years (USPSTF 2009).

However, within expanded and non-expanded Appalachia states, screening declined in the post- versus pre-expansion period. In non-Appalachia states, screening was lower in non-expanded states compared with expanded states in both pre- and post-expansion periods, and within expanded and non-expanded states, screening declined in the post-expansion period compared with pre-expansion period.

Previous studies have examined the impact of Medicaid expansion on self-reported breast cancer screening among US adults.^{3,26,33-40} Similar to our findings, other studies have observed significant reductions in breast cancer screening in the post-expansion period.^{26,34-36,39} Two US studies^{26,36} found a 13%²⁶ and 20%³⁶ reduced odds of breast cancer

screening in the post-expansion period among women aged 50 to 74 years. We observed that in non-expanded Appalachia states, women aged 50 to 59 years had marginally higher screening in both the pre- and post-expansion periods. However, among women aged 60 to 69 years, screening was marginally higher in the pre-expansion compared to the post-expansion period, but was marginally higher among women aged 70 to 74 years higher in the postexpansion compared to the pre-expansion period.

In non-expanded non-Appalachia states, screening was lower across all the age groups consistently in the post-expansion compared to the pre-expansion period. In the pre-expansion period, screening was lowest among women aged

Table 3. Relative Risks for Breast Cancer Screening by Medicaid Expansion Status and Age-Group, US BRFSS 2003 to 2015.^a

Year	Breast Cancer Screening			
	Appalachia		Non-Appalachia	
	2003-2009	2011-2015	2003-2009	2011-2015
Overall US				
Expanded	30 832 (84.49)	15 817 (82.59)	120 100 (85.28)	46 028 (83.38)
Nonexpanded	47 801 (84.92)	15 037 (82.61)	76 145 (82.97)	27 446 (79.54)
	RR = 1.002 (1.002-1.003)	RR = 1.001 (1.001-1.002)	RR = 0.978 (0.978-0.979)	RR = 0.958 (0.955-0.959)
50-59 years				
Expanded	14 265 (83.71)	6468 (81.05)	56 043 (84.20)	18 539 (81.81)
Nonexpanded	21 404 (84.03)	5757 (81.12)	34 218 (81.64)	10 916 (78.13)
	RR = 1.004 (1.00-1.008)	RR = 1.005 (1.004-1.006)	RR = 0.975 (0.974-0.976)	RR = 0.961 (0.960-0.962)
60-69 years				
Expanded	11 829 (84.94)	6817 (83.69)	46 100 (86.12)	19 888 (84.57)
Nonexpanded	18 901 (85.35)	6632 (83.31)	29 401 (83.87)	11 727 (80.30)
	RR = 1.005 (1.005-1.006)	RR = 0.996 (0.995-0.997)	RR = 0.981 (0.979-0.982)	RR = 0.956 (0.955-0.957)
70-74 years				
Expanded	4738 (85.77)	2532 (83.72)	17 957 (86.47)	7601 (84.25)
Nonexpanded	7496 (86.36)	2648 (84.22)	12 526 (84.49)	4803 (80.97)
	RR = 0.99 (0.989-1.00)	RR = 1.012 (1.011-1.013)	RR = 0.98 (0.979-0.981)	RR = 0.961 (0.9609-0.962)

Abbreviations: ACA, Affordable Care Act; BRFSS, Behavioral Risk Factor Surveillance System; Reference = Expanded; RR, relative risk.

^aExcluded 2010 data as the washout period. RRs for age categories have been adjusted for race, annual household income, and educational status using Proc Genmod.

Table 4. Relative Risks for Breast Cancer Screening for Overall and Low-Income Women by Expansion and Time Period, US BRFSS 2003 to 2015.^a

Expansion status	Overall ^b		Low Income ^c (\leq \$20 000) ^d	
	Appalachia RR (95% CI)	Non-Appalachia RR (95% CI)	Appalachia RR (95% CI)	Non-Appalachia RR (95% CI)
Expanded				
Pre-expansion (2003-2009)	Ref	Ref	Ref	Ref
Postexpansion (2011-2015)	0.972 (0.969-0.973)	0.956 (0.949-0.957)	0.961 (0.959-0.961)	0.937 (0.936-0.938)
Nonexpanded				
Pre-expansion (2003-2009)	Ref	Ref	Ref	Ref
Postexpansion (2011-2015)	0.970 (0.969-0.971)	0.978 (0.969-0.978)	0.972 (0.969-0.973)	0.978 (0.977-0.979)

Abbreviations: BRFSS, Behavioral Risk Factor Surveillance System; CI, confidence interval; RR, relative risk.

^aRelative risks were adjusted for sex, race, annual household income, educational status including interaction terms for expansion status and time periods of pre- and postexpansion using Proc Genmod. Excluded 2010 data as the washout period.

^bP value for expand \times period interaction: <.0001.

^cP value for expand \times period interaction: .0019.

^dAnnual household income \leq \$20 000.

50 to 59 years, while in the postexpansion period, screening was lowest among women aged 60 to 69 years.

A previous study also reported a 28% reduction in screening during 2009 to 2010 compared with 2004 to 2005 using the Medical Expenditure Panel Survey.³⁷ Two cross-sectional studies using the BRFSS found higher prevalence of self-reported mammography in the expanded states of 5%³³ and 3%⁴⁰ in 2012 and 2014, respectively, and a separate study observed that among low-income women, screening rates were 8% higher in expanded states compared to nonexpanded states.⁴⁰ Our study adds more recent, empirical data regarding the impact of Medicaid expansion on breast cancer screening in

the United States and reveals that, in general, there were declines in breast cancer screening in the post-ACA period in both expanded and non-expanded states, regardless of Appalachia status. There are several possible reasons for these observations, including state-level differences in Medicaid expansion eligibility and requirements, lack of information regarding insurance benefits, confusion about changing guidelines regarding appropriate timing and frequency of screening, or lack of health-care provider recommendation.

First, we observed the lowest breast cancer screening prevalence among women with no regular health-care provider (55% in expanded non-Appalachia states; 54% in non-

expanded non-Appalachia states, 54% in expanded Appalachia states; and 59% in non-expanded Appalachia states), suggesting that lack of provider recommendation remains a strong predictor of routine screening regardless of expansion or Appalachia status, as shown in previous studies.⁴¹⁻⁴⁴ Second, while the ACA aimed to provide free or reduced cost coverage for screening services that were previously not available and/or affordable, some studies have reported significant administrative barriers that reduced utilization of this benefit, such as out-of-network fees or restrictions on grandfathered plans.³⁴ In addition, insurance coverage through the ACA may not necessarily guarantee receipt of those services.⁴⁵ States were given latitude to establish their own Medicaid eligibility requirements and reimbursements, and given significant variation in eligibility and administrative requirements across states in Medicaid programs,²¹⁻²⁴ utilization of the benefit for preventive care, including breast cancer screening, may be negatively affected. Further, according to the Kaiser Family Foundation, awareness of the provisions of the ACA policy remains low; in a 2014 poll, only 43% of Americans were aware of the free preventive health-care benefits available as part of the ACA.²⁰

Third, a recent study observed that despite the availability of screening services, most of the women in the target population are not screened due to lack of knowledge of screening guidelines or transportation issues and lack of providers in proximity,⁴⁶ suggesting that lack of access to health care, independent of insurance status, remains a significant barrier to breast cancer screening. Future studies are needed to better target these disparate populations and address barriers to health-care access. Fourth, while self-reported measures of women's cancer screening in the BRFSS have been validated^{47,48} as we and others have shown that^{34-37,39} self-reported measures of breast cancer screening are subject to recall bias⁴⁹ resulting in misclassification, with a significant proportion of participants overreporting screening practices. Data using objective measures of screening from claims data across Medicaid expansion and Appalachia states may be necessary to definitively estimate the impact of the ACA on breast cancer screening in the United States.

There were certain limitations relevant to this study. First, given that breast cancer screening information in the BRFSS are only assessed in the BRFSS in even years, we were able to analyze only 2 years of data for 2012 and 2014 in the ACA Medicaid post-expansion period, which may be too short to fully capture the influence of ACA expansion on screening. Future studies based on a longer follow-up period from ACA expansion will help to further clarify these findings. Also, we were unable to assess screening among respondents based on the type of insurance, duration of the insurance, and also if the type of insurance was adequate to cover screening services. The BRFSS asked whether respondents have insurance but not type of coverage (Medicaid, Medicare, or private); therefore, we were unable to compare differences based on insurance types. Second, in 2010, the BRFSS introduces a new weighting method, which replaced the poststratification method with

raking (iterative proportional fitting).⁵⁰ According to the CDC, comparison between years before and after these changes may have been affected.⁵⁰ We examined the trends in the pre-expansion period (2003-2009) and postexpansion periods (2011-2015) by categorizing expanded and nonexpanded states and examining the trends while considering calendar year 2010 as our washout period. Another methodological change in 2011 was the addition of cell phone numbers along with landline telephones numbers to administer the BRFSS survey, while prior surveys utilized landline telephone numbers exclusively. Third, evaluation of the impact of the ACA Medicaid expansion policy on breast cancer screening may be vulnerable to ecological bias; however, this approach is used extensively to assess state-wide health policies, and we utilized statistically rigorous approaches to our analysis, including comparing pre- and postexpansion screening rates among expanded and non-expanded states and utilizing multivariable adjusted regression models to account for study covariates.

This study addresses several of the gaps in previous literature on this topic. Specifically, we compared expansion status based on Appalachia status. Prior studies have shown that women in Appalachia regions have much lower breast cancer screening rates and significantly higher mortality rates compared to the national average,^{11,16} although none of the prior studies have evaluated the role of ACA expansion in this region. Second, the analysis evaluated differences in screening rates by pre- and post-expansion status. Other studies have only evaluated differences in screening postexpansion only, without accounting for baseline screening levels.^{26,40} Also, our analyses include a large sample size, racial and socio-economically diverse study population, and a nationally representative source of data that enhances generalizability, while the use of standardized interview questions across all the survey years that enhances the reliability of our main study measure.

In summary, breast cancer screening rates were higher in Appalachia versus non-Appalachia US states, and higher in expanded versus nonexpanded non-Appalachia states. There were also modest declines in breast cancer screening rates in the post-expansion period regardless of expansion and Appalachia status, suggesting that more work is needed to reduce administrative, logistical, and structural barriers to breast cancer screening services for US women.

Authors' Note

The data sets analyzed during the current study were derived from the following public domain resources: https://www.cdc.gov/brfss/annual_data/annual_data.htm. No institutional IRB approval is required as BRFSS data are publicly available and do not meet the regulatory criteria for human subjects' research. Tomi Akinyemiju is also affiliated to Department of Population Health Sciences, Duke University School of Medicine, Durham, NC, USA.

Declaration of Conflicting Interests

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References

- DeSantis CE, Ma J, Goding Sauer A, Newman LA, Jemal A. Breast cancer statistics, 2017, racial disparity in mortality by state. *CA Cancer J Clin.* 2017;67(6):439-448.
- Gotzsche PC, Jorgensen KJ. Screening for breast cancer with mammography. *Cochrane Database Syst Rev.* 2013(6):CD001877.
- Nelson HD, Tyne K, Naik A, et al. Screening for breast cancer: systematic evidence review update for the U.S. Preventive Services Task Force. *Ann Int Med.* 2009;151(10):727-W242.
- Tabar L, Vitak B, Chen TH, et al. Swedish two-county trial: impact of mammographic screening on breast cancer mortality during 3 decades. *Radiology.* 2011;260(3):658-663.
- Kimmick GG, Camacho F, Mackley HB, et al. Individual, area, and provider characteristics associated with care received for stages I to III breast cancer in a multistate region of Appalachia. *J Oncol Pract.* 2015;11(1):e9-e18.
- Donohoe J, Marshall V, Tan X, Camacho FT, Anderson R, Balkrishnan R. Predicting late-stage breast cancer diagnosis and receipt of adjuvant therapy: applying current spatial access to care methods in Appalachia. *Med Care.* 2015;53(11):980-988.
- Barker L, Gerzoff R, Crespo R, Shrewsbury M. Age at diagnosis of diabetes in Appalachia. *Popul Health Metr.* 2011;9:54.
- Halverson J, Lin MHE. *An Analysis of Disparities in Health Status and Access to Health Care in the Appalachian Region.* Washington, DC: Appalachian Regional Commission; 2004.
- Lengerich EJ, Tucker TC, Powell RK, et al. Cancer incidence in Kentucky, Pennsylvania, and West Virginia: disparities in Appalachia. *J Rural Health.* 2005;21(1):39-47.
- Braun KL, Stewart S, Baquet C, et al. The National Cancer Institute's Community Networks Program Initiative to Reduce Cancer Health Disparities: outcomes and lessons learned. *Prog Community Health Partnersh.* 2015;9(suppl):21-32.
- Cohen EL, Wilson BR, Vanderpool RC, Collins T. Identifying sociocultural barriers to mammography adherence among Appalachian Kentucky women. *Health Commun.* 2016;31(1):72-82.
- Hall HI, Uhler RJ, Coughlin SS, Miller DS. Breast and cervical cancer screening among Appalachian women. *Cancer Epidemiol Biomarkers Prev.* 2002;11(1):137.
- Schoenberg NE, Studts CR, Hatcher-Keller J, Buelte E, Adams E. Patterns and determinants of breast and cervical cancer non-screening among Appalachian women. *Women Health.* 2013;53(6):552-571.
- Lengerich EJ, Wyatt SW, Rubio A, et al. The Appalachia Cancer Network: cancer control research among a rural, medically underserved population. *J Rural Health.* 2004;20(2):181-187.
- Huang B, Dignan M, Han D, Johnson O. Does distance matter? Distance to mammography facilities and stage at diagnosis of breast cancer in Kentucky. *J Rural Health.* 2009;25(4):366-371.
- Anderson RT, Yang TC, Matthews SA, et al. Breast cancer screening, area deprivation, and later-stage breast cancer in Appalachia: does geography matter? *Health Serv Res.* 2014;49(2):546-567.
- Behringer B, Friedell GH. Appalachia: where place matters in health. *Prev Chronic Dis.* 2006;3(4):A113.
- Donohoe J, Marshall V, Tan X, Camacho FT, Anderson RT, Balkrishnan R. Spatial access to primary care providers in Appalachia: evaluating current methodology. *J Prim Care Community Health.* 2016;7(3):149-158.
- Smith J, Medalia C. *Health Insurance in the United States: 2013.* Washington, DC: US Census Bureau; 2014.
- Hamel L, Firth J, Brodie M. *Kaiser Health Tracking Poll: March 2014.* 2014. <http://kff.org/health-reform/poll-finding/kaiser-health-tracking-poll-march-2014/>. Accessed August 10, 2018.
- Blumberg LJ, Garrett B, Holahan J. Estimating the counterfactual: how many uninsured adults would there be today without the ACA? *INQUIRY: The Journal of Health Care Organization, Provision, and Financing.* 2016;53:0046958016634991.
- Obama B. United States health care reform: progress to date and next steps. *JAMA.* 2016;316(5):525-532.
- Okoro CA, Zhao G, Dhingra SS, Xu F. Lack of health insurance among adults aged 18 to 64 years: findings from the 2013 Behavioral Risk Factor Surveillance System. *Prev Chronic Dis.* 2015;12:E231.
- Sommers BD, Gunja MZ, Finegold K, Musco T. Changes in self-reported insurance coverage, access to care, and health under the Affordable Care Act. *JAMA.* 2015;314(4):366-374.
- Gostin LO, Garcia KK. Affordable Care Act litigation: the Supreme Court and the future of health care reform. *JAMA.* 2012;307(4):369-370.
- Sabik LM, Tarazi WW, Bradley CJ. State Medicaid expansion decisions and disparities in women's cancer screening. *Am J Prev Med.* 2015;48(1):98-103.
- Sommers BD, Arntson E, Kenney GM, Epstein AM. Lessons from early Medicaid expansions under health reform: interviews with Medicaid officials. *Medicare Medicaid Res Rev.* 2013;3(4):pii:mmrr.003.04.a02.
- US Preventive Services Task Force. Screening for breast cancer: U.S. Preventive Services Task Force recommendation statement. *Ann Intern Med.* 2009;151(10):716-726.
- Sabik LM, Adunlin G. The ACA and cancer screening and diagnosis. *Cancer J.* 2017;23(3):151-162.
- The Centers for Disease Control and Prevention. *The BRFSS Data User Guide.* Atlanta, GA: Department of Health and Human Services; 2013.
- Mokdad AH. The Behavioral Risk Factors Surveillance System: past, present, and future. *Annu Rev Public Health.* 2009;30:43-54.
- The Appalachian Regional Commission. *Counties in Appalachia.* The Appalachian Regional Commission. https://www.arc.gov/appalachian_region/countiesinappalachia.asp. Accessed April 15, 2019.
- Choi SK, Adams SA, Eberth JM, et al. Medicaid coverage expansion and implications for cancer disparities. *Am J Public Health.* 2015;105(suppl 5):S706-S712.
- Cooper GS, Kou TD, Dor A, Koroukian SM, Schluchter MD. Cancer preventive services, socioeconomic status, and the Affordable Care Act. *Cancer.* 2017;123(9):1585-1589.

35. Han X, Robin Yabroff K, Guy GP, Zheng Z, Jemal A. Has recommended preventive service use increased after elimination of cost-sharing as part of the Affordable Care Act in the United States? *Prev Med*. 2015;78:85-91.
36. Wyatt TE, Pernenkil V, Akinyemiju TF. Trends in breast and colorectal cancer screening among U.S. adults by race, healthcare coverage, and SES before, during, and after the great recession. *Prev Med Rep*. 2017;7:239-245.
37. King CJ, Chen J, Garza MA, Thomas SB. Breast and cervical screening by race/ethnicity: comparative analyses before and during the Great Recession. *Am J Prev Med*. 2014;46(4):359-367.
38. Marino M, Bailey SR, Gold R, et al. Receipt of preventive services after Oregon's Randomized Medicaid Experiment. *Am J Prev Med*. 2016;50(2):161-170.
39. Meeker D, Joyce GF, Malkin J, Teutsch SM, Haddix AC, Goldman DP. Coverage and preventive screening. *Health Serv Res*. 2011;46(1 pt 1):173-184.
40. Okoro CA, Zhao G, Fox JB, Eke PI, Greenlund KJ, Town M. Surveillance for health care access and health services use, adults aged 18-64 years—Behavioral Risk Factor Surveillance System, United States, 2014. *MMWR Surveill Summ*. 2017;66(7):1-42.
41. Akinyemiju TF, Soliman AS, Yassine M, Banerjee M, Schwartz K, Merajver S. Healthcare access and mammography screening in Michigan: a multilevel cross-sectional study. *Int J Equity Health*. 2012;11:16.
42. DeVoe JE, Fryer GE, Phillips R, Green L. Receipt of preventive care among adults: insurance status and usual source of care. *Am J Public Health*. 2003;93(5):786-791.
43. Garcia RZ, Carvajal SC, Wilkinson AV, et al. Factors that influence mammography use and breast cancer detection among Mexican-American and African-American women. *Cancer Causes Control*. 2012;23(1):165-173.
44. Rahman SM, Dignan MB, Shelton BJ. Factors influencing adherence to guidelines for screening mammography among women aged 40 years and older. *Ethn Dis*. 2003;13(4):477-484.
45. Alexandra G, Ranji U, Snyder L. *Coverage of Preventive Services for Adults in Medicaid*. Washington, DC: Kaiser Commission on Medicaid and the Uninsured; 2014.
46. Tangka FK, Howard DH, Royalty J, et al. 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*. 2015;26(5):671-686.
47. Caplan LS, McQueen DV, Qualters JR, Leff M, Garrett C, Calonge N. Validity of women's self-reports of cancer screening test utilization in a managed care population. *Cancer Epidemiol Biomarkers Prev*. 2003;12(11 pt 1):1182-1187.
48. Zapka JG, Bigelow C, Hurley T, et al. Mammography use among sociodemographically diverse women: the accuracy of self-report. *Am J Public Health*. 1996;86(7):1016-1021.
49. Rauscher GH, Johnson TP, Cho YI, Walk JA. Accuracy of self-reported cancer-screening histories: a meta-analysis. *Cancer Epidemiol Biomarkers Prev*. 2008;17(4):748-757.
50. Centers for Disease Control and Prevention. Methodologic changes in the Behavioral Risk Factor Surveillance System in 2011 and potential effects on prevalence estimates. *MMWR Morb Mortal Wkly Rep*. 2012;61(22):410-413.