Medicaid Expansions and Cervical Cancer Screening for Low-Income Women

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Objective. Medicaid coverage for low-income women may play an important role in ensuring access to preventive care. This study examines how Medicaid eligibility expansions to nonelderly adults impact cervical cancer screening among low-income women.

Data Sources. We use data from the Behavioral Risk Factor Surveillance System from 2000 to 2010. The primary outcome of interest is whether women in the relevant guideline consistent age range reported having a Pap test in the previous year.

Study Design. We use a difference-in-differences approach with matched treatment and comparison states and a simulated eligibility approach based on a continuous measure of Medicaid generosity.

Principal Findings. Our results indicate that cervical cancer screening increased among low-income women in expansion states relative to comparison states. Increases in screening rates are largest among low-income Hispanic women.

Conclusions. Medicaid expansions during the period from 2000 to 2010 were associated with improved cervical cancer screening rates, which is critical for early cervical cancer detection and prevention of cancer morbidity and mortality in women. The results suggest that more widespread Medicaid expansions may have positive effects on preventive health care for women.

Key Words. Medicaid, insurance, cervical cancer, screening, prevention

Among U.S. women, there are over 4,000 deaths from cervical cancer each year (American Cancer Society 2016), despite the fact that the disease could be practically eliminated with screening and early treatment. Screening rates for cervical cancer remain substantially below target rates set by Healthy People 2020, particularly among low-income and racial and ethnic minorities (Sabatino et al. 2015; Office of Disease Prevention and Health Promotion 2016). These groups of women also have poorer access to health care,

although Medicaid expansions to nonelderly adults may partially ameliorate limited access among low-income women and improve health outcomes, including mortality (Sommers, Baicker, and Epstein 2012). While Medicaid expansions are associated with improvements in mortality (Sommers, Baicker, and Epstein 2012; Sommers, Long, and Baicker 2014), more evidence is needed on the underlying mechanisms. Cervical cancer screening is a recommended (U.S. Preventive Services Task Force 2012) and broadly available preventive service. The impact of public insurance coverage expansions on cervical cancer screening has implications for cervical cancer outcomes and for understanding the factors that influence the use of preventive services.

Other federal and state programs support the provision of free or low-cost cervical cancer screening to low-income women. Funding for family planning clinics through Title X and expansions of Medicaid family planning coverage through 1115 waivers both increase receipt of cervical cancer screening among targeted populations (Wherry 2013b; Nikpay 2016), and the National Breast and Cervical Cancer Early Detection Program (NBCCEDP) through the Centers for Disease Control and Prevention (CDC) has offered free screening to eligible women since 1990. Despite improved screening rates among low-income women, the program has been unable to reach many eligible women, and research shows that disparities by income, insurance, and ethnicity remain (Adams, Breen, and Joski 2007; Tangka et al. 2010). This may be attributable to the program's limited budget and uninsured women's lack of awareness of program benefits. In contrast, evidence from coverage expansions under Massachusetts health reform suggests that near-universal coverage increases cancer screening, indicating an impact of comprehensive coverage beyond that of safety net programs in existence prior to expansion (Sabik and Bradley 2016). We hypothesize that full Medicaid coverage that may promote engagement with the health care and link women to primary care will increase use of preventive services such as cervical cancer screening, despite the presence of the family planning and NBCCEDP programs.

This study examines how changes in Medicaid eligibility for nonelderly adults prior to the Affordable Care Act impacted cervical cancer screening. Although a broader population of adults is now covered by Medicaid under

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the ACA, there are lessons to be learned from pre-ACA expansions. These expansions occurred during a period when there were fewer simultaneous changes in the health care system. In particular, under the ACA, there have been multiple policy changes targeting low-income populations (e.g., through various Medicaid delivery reforms and subsidized private insurance) that make it difficult to isolate the effects of public coverage expansion alone. We find evidence of improvements in cervical cancer screening rates among low-income women, suggesting that public coverage expansions may improve receipt of preventive care services among this population.

BACKGROUND

Medicaid, which is financed jointly by federal and state governments and administered by states, provides health insurance coverage to low-income and disabled individuals. We focus in this study on expansions of Medicaid coverage to nonelderly adults that occurred prior to the passage of the ACA. While the primary nonelderly groups traditionally covered by Medicaid were low-income children, parents, and pregnant women, some state Medicaid programs covered nondisabled childless adults and parents at higher-than-standard income levels under 1115 waivers from the Centers for Medicare and Medicaid Services, allowing them to expand coverage to nonmandatory populations (Centers for Medicare and Medicaid Services 2016).

The conceptual framework for our analysis draws on Andersen's model of access to health services as adapted by the Institute of Medicine (Andersen and Davidson 2001; Institute of Medicine 2001). Specifically, availability of insurance coverage (including eligibility guidelines within an individual's state) is an important factor in determining coverage and interacts with individual characteristics, including income and household characteristics that determine individual eligibility as well as other factors related to an individual's ability to enroll in and maintain coverage. These factors inform our hypotheses that cervical cancer screening rates among low-income women will be higher in states with expanded Medicaid eligibility for adults and that racial and ethnic disparities in screening will be ameliorated by expanded eligibility.

Medicaid expansions prior to the ACA increased coverage among adult populations across a number of states (Gilmer, Kronick, and Rice 2005; Long, Zuckerman, and Graves 2006; Atherly et al. 2012), but there is limited and mixed evidence on the effect of these coverage expansions on health care

utilization, including preventive care (Howell 2001; Levy and Meltzer 2004). Sicker individuals who are more likely to have poor health outcomes tend to enroll in Medicaid, confounding observational assessments of outcomes. In contrast, evidence using experimental or quasi-experimental designs suggests that Medicaid improves access to health care and may also improve outcomes. Results from the Oregon Health Insurance Experiment that randomized individuals to Medicaid eligibility suggest that those who gained Medicaid coverage had significantly higher health care utilization and better self-reported physical and mental health than the control group (Finkelstein et al. 2012; Baicker et al. 2013). Sommers et al. used a quasi-experimental design comparing three states that substantially expanded adult Medicaid eligibility with neighboring control states and found that county-level mortality was significantly reduced in expansion states, particularly among older adults, minorities, and those in poorer counties (Sommers, Baicker, and Epstein 2012). Part of this improvement in health outcomes may be due to changes in preventive care service use.

Cervical cancer screening is recommended for a large segment of the population targeted by Medicaid expansions (most women aged 21 and older) (U.S. Preventive Services Task Force 2012). Despite being widely recommended and simple and inexpensive to perform, cervical cancer screening rates are below recommended targets and screening is particularly underutilized by certain racial and ethnic minorities (Sabatino et al. 2015). Women with lower rates of recommended screening, such as Hispanic women, also experience significantly higher incidence of cervical cancer (McDougall et al. 2007; Siegel, Miller, and Jemal 2015).

Recent evidence on coverage mandates affecting private insurance shows that these mandates increase screening, particularly for Hispanic women, suggesting that insurance coverage is an important factor in determining whether women are screened (Bitler and Carpenter 2017). There is limited evidence regarding the effects of public insurance coverage expansions to the nonelderly on cervical cancer screening. Evidence from insurance expansions under Massachusetts health reform shows significant increases in Pap tests, particularly among low-income women (Sabik and Bradley 2016). Two studies that consider the effects of Medicaid expansions specifically also find significant positive effects. Research on Medicaid expansions after the passage of the Personal Responsibility and Work Opportunity Reconciliation Act (PRWORA) in 1996 found a positive effect of early eligibility expansions on Pap tests (Busch and Duchovny 2005). The Oregon Health Insurance Experiment, in which low-income adults were randomly given the opportunity to

enroll in Medicaid coverage, found a statistically significant 45 percent increase in the probability of having a Pap test after 1 year of coverage compared to those who were randomized to the no-insurance group (Finkelstein et al. 2012). We expand on that literature using more recent expansions to both parents and childless adults in a sample that includes many more states and consider how changes in cervical cancer screening may have differed across racial and ethnic groups. This study also expands on the literature using two complementary methodological approaches—both a difference-in-differences approach and a simulated eligibility approach (Currie and Gruber 1996)—to assess the impact of Medicaid expansions on women's cancer screening. Using both approaches, we test the robustness of the results under different estimation methods.

DATA AND METHODS

Overview of Analytic Approach

The goal of this study was to estimate the effect of increases in Medicaid eligibility for nondisabled adults on the receipt of cervical cancer screening among nonelderly adult women. The implementation of multiple Medicaid waivers expanding adult coverage over the period from 2000 to 2010 represents a useful source of variation and natural experiment for assessing the effects of Medicaid expansions.

We use two different but complementary approaches to ensure the robustness of results. The first approach uses a difference-in-differences (DD) framework in which states are categorized as expansion (treatment) or nonexpansion (control) and matched so that the postexpansion period is defined by the implementation date in the matched expansion state (Sommers, Baicker, and Epstein 2012). This approach estimates the overall average effect of an expansion, controlling for secular trends in screening using the nonexpansion comparison states. A number of states fall into a third category because they had smaller scale or state-funded expansions that may have led to some increase in public coverage, although not as large as in states with more comprehensive Medicaid expansions. Thus, we exclude these states from the DD analysis.

The second approach uses a simulated eligibility (SE) measure, which represents the generosity of Medicaid coverage for nonelderly, nondisabled adults in each state and year as the independent variable of interest. This measure is based on the percentage of a national sample of nonelderly adults in

each year that would be eligible for Medicaid in each state given the state's eligibility rules in that year (Currie and Gruber 1996). Thus, we estimate the change in screening associated with a discrete change in the generosity of Medicaid eligibility, independent of actual changes in eligibility that may be correlated with other factors, such as state-level unemployment, that could also affect health care utilization. This approach allows us to include all states in the analysis and account for heterogeneity in income eligibility levels across states.

Finally, multiple states implemented Medicaid family planning waivers during our study period. These waivers expanded income eligibility for family planning services, including cervical cancer screening, to women who were not eligible for full Medicaid coverage. Thus, we test the sensitivity of our results to controlling for these waivers. Based on published information on the month of family planning waiver implementation across states (Wherry 2013a), we create a variable equal to one for states with Medicaid family planning waivers during the time period the family planning waiver was in place and re-estimate our models including this control.

Individual-Level Data

We use data from the Behavioral Risk Factor Surveillance System (BRFSS) between 2000 and 2010 to consider receipt of Pap tests among a sample of women 21 to 64 years of age who have not had a hysterectomy. The BRFSS is a cross-sectional telephone survey conducted annually in each state that collects data on demographics, health care coverage and access, health behaviors, and preventive care. The women's health module, which includes questions on cervical cancer screening, is fielded nationally every two years. Thus, we use data from six cross-sections of the BRFSS.

We use data on length of time since last Pap test to consider changes in cervical cancer screening after Medicaid expansions. Guidelines from the American Cancer Society (ACS), the US Preventive Services Task Force (USPSTF), and the National Cancer Institute (NCI) have changed over time and differ regarding recommended screening intervals. Over our study period, cervical cancer screening guidelines ranged from 1- to 3-year intervals. We focus on annual screening as some guidelines recommended yearly screening throughout our study period and insurance generally continued to cover annual screening. We consider whether a woman reports having had a Pap test in the past year because recall bias is smaller over a shorter time period, some sets of major guidelines recommended annual screening during the

study period, and Medicaid plans often cover annual screening. In addition, we use demographic data on age, race, ethnicity, marital status, education, employment, and income to control for individual-level factors that may impact receipt of screening. We construct measures of income as a percent of federal poverty level (FPL) by assigning each individual the midpoint of household income in the category reported for her (e.g., if an individual falls into the category \$0 to \$10,000, she is assigned a value of \$5,000) and using yearly Department of Health and Human Services guidelines for federal poverty standards by household size.

State-Level Data

Medicaid income eligibility information for nonelderly, nondisabled adults came from multiple sources. Reports from the Kaiser Family Foundation provided information on parental coverage (Kaiser Family Foundation 2016). This was supplemented with information from other reports and administrative documents from foundations, states, and the Centers for Medicare and Medicaid Services (see Appendix SA2 for more detail). Certain gaps in information were addressed through conversations with state officials. From these sources, we compiled a state-year level dataset of Medicaid income eligibility thresholds as a percent of FPL for parents and childless adults in each state-year through multiple pathways, including traditional 1931 parental coverage, 1115 waiver coverage, and coverage through the Health Insurance Flexibility and Accountability (HIFA) waiver program (Atherly et al. 2012).

The simulated eligibility measure is constructed based on annual samples of 3,000 nonelderly adults aged 20 to 64 years in the Current Population Survey March Supplement. For each individual, we calculate income as a percent of FPL based on family size, state of residence, and survey year. We then determine individuals' eligibility for Medicaid in each state in a given year by comparing parental status, employment status, and income to each state's annual eligibility rules. The simulated eligibility measure is the percentage of the national nonelderly adult sample for a given year that would be eligible for Medicaid in each state. As eligibility for programs in California is based on county of residence, we use a weighted average of county-specific simulated eligibility as an overall California measure. We include eligibility through all Medicaid pathways that provide comprehensive coverage (excluding a small number of waiver programs that primarily provide premium support for

employer-sponsored health insurance); we do not include information on solely state-funded coverage programs.

Difference-in-Differences Models

We estimate difference-in-differences (DD) models comparing changes in cervical cancer screening in expansion states before and after the expansion of Medicaid eligibility to changes in similar neighboring states that did not implement expansions over the same time periods. We identified the potential control states for each of the expansion states as states in the same census region that did not have any expansion (federal or state-funded) during the study period. We selected one or more control states from the candidate list for each state based on geographic proximity and state population and demographic composition. The matched states and the postperiods for each pair are reported in Table 1.

We estimate DD regressions of the form:

$$Y_{ijt} = \beta_0 + \beta_1 MCDEXP_{jt} + \beta_2 EXP_j + \beta_3 POST_t + \mathbf{X}_{ijt}\boldsymbol{\delta} + \gamma_j + \tau_t\pi YEAR_t \\ * TREATMENT - CONTROL_s + \varepsilon_{ijt}$$

where Y_{ijt} is an indicator that represents the receipt of screening by the i th individual, in the j th state (part of treatment-control matched group s), and the t th year. $MCDEXP_{jt}$ is a dummy variable that is equal to one for women in one of the expansion states after the implementation of the expansion; this variable

Table 1: Treatment and Control States and Dates of Expansion Used in Difference-in-Differences Analysis

<i>Expansion State</i>	<i>Control State(s)</i>	<i>Postperiod Start*</i>
Arizona	Montana	11/2001
California	Nevada	7/2007
Indiana	Missouri	1/2008
Iowa	Nebraska, Kansas	7/2005
Maine	New Hampshire	10/2002
Maryland	Virginia	7/2009
New Mexico	Wyoming	7/2005
New York	Rhode Island	9/2001
Oklahoma	Kentucky, Alabama	7/2005

*Postperiod begins the month after the expansion took effect. Arizona had expansions for childless adults in November 2001 and parents in October 2002, so we use the earlier date as the start of the postperiod.

represents the interaction between an indicator for being in an expansion state and in the postperiod. Thus, β_1 is our key coefficient of interest representing the DD estimate. EXP_j is an indicator for being in an expansion state, and $POST_t$ is a matched treatment-control group indicator for the period after the expansion in the relevant expansion state. The $\mathbf{X}_{ijt}$ term represents a vector of demographic covariates, including age, marital status (married vs. not married), education (in six categories ranging from kindergarten or less to college graduate), employment status (employed vs. unemployed or not in the workforce), household income (in eight categories ranging from less than \$10,000 to \$75,000 or more), and race that account for key predisposing and enabling characteristics in the context of the Andersen model (Andersen and Davidson 2001); δ represents a vector of the corresponding demographic parameter coefficients.¹ The term γ_j represents a set of state fixed effects that control for any time-invariant state characteristics that might affect our outcomes, and τ_t represents year fixed effects that control for general time trends. We also include a set of treatment and control group-specific time trends represented by π to adjust for any distinct regional time trends specific to the group. We estimate linear probability models for ease of interpretation and to avoid issues with interaction terms in nonlinear models (Ai and Norton 2003). We employ survey weights that account for the BRFSS complex sampling design in all models. We estimate all models for the full sample of screening eligible women as well as subsamples of women with incomes under 200 percent FPL, who are most likely to be affected by the expansions.

Simulated Eligibility Models

We estimate a second set of models that considers the relationship between the measure of nonelderly adult simulated eligibility in a given state and year and receipt of screening. Using the sample of women from all states, we estimate linear probability model of the form:

$$Y_{ijt} = \beta_0 + \beta_1 SimElig_{jt} + \mathbf{X}_{ijt}\delta + \gamma_j + \tau_t + \varepsilon_{ijt}$$

Variables are defined as above, although the independent variable of interest is $SimElig_{jt}$, which represents the percentage of a consistent national sample of nonelderly adults in each year that is eligible for Medicaid under each state's rules and captures the generosity of Medicaid eligibility for adults in the j th state and t th year. We again include state and year fixed effects, so our estimates are based on within-state variation in simulated eligibility over

time. We scale the coefficients to represent a 10 percentage point change in simulated eligibility.

RESULTS

State-Level Adult Medicaid Eligibility

From 2000 to 2010, Medicaid eligibility for adults is increasing, on average, across states. Table 2 presents income eligibility thresholds for Medicaid in 2000 and 2010 for parents and childless adults. Over 20 states implemented expansions to nondisabled adults over this period. In 2000, only five states offered Medicaid coverage for childless adults, increasing to 18 states in 2010. Appendix SA3 includes additional information regarding Medicaid expansions to childless adults and parents over the period from 2000 to 2010, including years of expansion. The increases in eligibility are also reflected in the simulated eligibility measure. To summarize, the mean difference between simulated eligibility in 2010 versus 2000 is 5 percentage points. Eight states experience a decline in simulated eligibility over this period, although these decreases are small (less than 2 percentage points) in all states except Tennessee, which experienced a large disenrollment from its Medicaid program over this period. Fifteen states have an increase in simulated eligibility of 10 percentage points or greater.

Descriptive Statistics

Table 3 reports weighted summary statistics for the sample of women targeted for Pap tests, both for all states and for the limited set of states included in the DD analysis (Table 1). The sample from the smaller set of states (column 2) resembles the full national sample of women aged 21 to 64 in terms of basic demographics. Of women in the target population, approximately 69 percent received a Pap test in the past year. We also examined trends in Pap test receipt separately for expansion and matched comparison states in our DD analysis in each of the 5 years leading up to expansion (results available upon request) and found that while rates were consistently higher in comparison states, trends were similar across the two groups, particularly in the 3 years prior to expansion. The mean age is 40 across both sets of states. About two-thirds of each sample are married and employed, and about 84 percent of the sample has health insurance coverage. The majority of both samples have above a high school education. The primary difference between the set of states

Table 2: Adult Medicaid Eligibility by State, Years 2000 and 2010

<i>State</i>	<i>Income Eligibility Threshold as % Federal Poverty Level</i>			
	<i>Parents</i>		<i>Childless Adults</i>	
	<i>2000</i>	<i>2010</i>	<i>2000</i>	<i>2010</i>
AL	21	24	—	—
AK	79	81	—	—
AZ*,§	100	106	—	100
AR [†]	21	17	—	—
CA [‡]	107	200	—	200
CO	42	106	—	—
CT*	68	191	—	56
DE*	100	121	100	100
DC*	200	207	—	200
FL	66	53	—	—
GA	42	50	—	—
HI	300	300	300	300
ID [†]	33	27	—	—
IL	56	185	—	—
IN	31	200	—	200
IA	87	250	—	250
KS	40	32	—	—
KY	75	62	—	—
LA	22	25	—	—
ME*	107	206	—	100
MD	43	116	—	116
MA*, [†]	133	133	—	—
MI	45	64	—	35
MN*	275	275	—	—
MS	38	44	—	—
MO	100	25	—	—
MT	69	56	—	—
NE [§]	55	58	—	—
NV [†]	87	88	—	—
NH	62	49	—	—
NJ*	38	200	—	—
NM	58	200	—	200
NY	75	150	—	100
NC	62	49	—	—
ND	81	59	—	—
OH	100	90	—	—
OK	48	200	—	200
OR [†]	100	100	100	100
PA*	40	34	—	—
RI	192	181	—	—
SC	55	89	—	—

continued

Table 2. *Continued*

<i>State</i>	<i>Income Eligibility Threshold as % Federal Poverty Level</i>			
	<i>Parents</i>		<i>Childless Adults</i>	
	<i>2000</i>	<i>2010</i>	<i>2000</i>	<i>2010</i>
SD	65	52	—	—
TN*	200	129	200	—
TX [§]	32	26	—	—
UT [†]	55	150	—	150
VT [†]	185	191	150	150
VA	31	29	—	—
WA*	90	74	—	—
WVs	28	33	—	—
WI	185	200	—	200
WY	65	52	—	—

Notes. Thresholds for adults covered through traditional Medicaid 1931 or 1115 waiver. Most generous threshold reported. In some states, jobless adults were covered at a lower threshold. Cells with no threshold listed did not cover the group in the given year.

*State-funded program for parents and/or childless adults also in place.

[†]Primarily premium assistance program for parents and/or childless adults also in place.

[§]Eligibility for programs in California determined by county of residence; not all counties cover eligible individuals at thresholds noted.

[§]Thresholds for jobless and/or working parents covered by traditional 1931 Medicaid were not available for 2000. We used the thresholds for parents covered by this pathway in 2001.

included in the DD analysis and the national sample is the racial and ethnic composition. Women in the smaller sample of states are less likely to be white or black and more likely to be Hispanic.

Difference-in-Differences Results

Table 4 presents DD estimates of the effect of Medicaid expansion on whether a woman had a Pap test in the past year. The variable “Medicaid expansion” in the first row of the table represents the DD estimate (the interaction between being in an expansion state and the postexpansion period). The coefficients indicate significant relative increases in Pap tests after expansion. The coefficient on the postexpansion indicator suggests an overall decline in annual screening, which reflects responses to changes in guidelines over this period. Based on the assumption that the nonexpansion states represent the counterfactual of how screening would have changed in the treatment states in the absence of expansion, the DD estimates suggest a relative increase in cervical cancer screening of 1.3 percentage points among the overall population and

Table 3: Descriptive Statistics, Women in All States and DD Analysis States

	(1) <i>All states</i>	(2) <i>DD analysis states</i>
Unweighted <i>N</i>	549,226	202,068
Weighted <i>N</i>	1,871,529	689,685
	<i>Mean(SE)/%</i>	<i>Mean(SE)/%</i>
Outcome		
Pap test in past year	69.40	69.25
Basic demographics		
Age	39.67(.030)	39.65(.055)
Married	62.78	61.27
Employed	67.95	66.80
Insured	83.85	84.01
Education		
Less than high school	8.52	10.45
High school graduate	24.98	23.62
Some college	28.75	28.30
College graduate	37.75	37.63
Household income		
Less than \$10,000	5.47	6.70
\$10,000–\$14,999	4.71	5.49
\$15,000–\$19,999	6.80	6.78
\$20,000–\$24,999	8.34	7.86
\$25,000–\$34,999	11.9	11.48
\$35,000–\$49,999	16.17	15.33
\$50,000–\$74,999	18.42	17.84
\$75,000 or more	28.20	28.51
Race/ethnicity		
White only, non-Hispanic	69.07	63.96
Black only, non-Hispanic	10.86	8.95
Other race only, non-Hispanic	4.63	6.05
Multiracial, non-Hispanic	1.18	1.46
Hispanic	14.26	19.57

Note. SE: linearized standard errors as calculated with *Stata* *svy* commands.

4.0 percentage points among low-income women in expansion versus nonexpansion states. This represents a 6.3 percent increase in screening for the low-income group relative to the mean screening rate of 63.2 percent in that population.

Columns (3)–(5) of Table 4 present results from DD regressions stratified by race/ethnicity. The results indicate that the significant effect seen among low-income women is driven by changes for low-income Hispanic

Table 4: Difference-in-Differences Models of Effect of Medicaid Expansion on Receipt of Pap Tests

	Low-Income (< 200% FPL)				
	All Income Levels	Overall	White Non-Hispanic	Black Non-Hispanic	Hispanic
Medicaid expansion	0.013* (.008)	0.040*** (.015)	0.020 (.017)	0.020 (.042)	0.134*** (.048)
Expansion state	-0.048*** (.010)	-0.060*** (.017)	-0.044** (.022)	-0.096*** (.035)	-0.037 (.078)
Post expansion	-0.047 (.040)	-0.138 (.090)	-0.144 (.106)	0.091 (.188)	0.000 (.238)
Age	-0.003*** (.000)	-0.005*** (.000)	-0.006*** (.000)	-0.005*** (.000)	-0.003*** (.001)
Married	0.051*** (.005)	0.048*** (.009)	0.029*** (.011)	0.013 (.026)	0.064*** (.018)
High school graduate	-0.004 (.010)	-0.001 (.012)	0.068*** (.016)	0.059** (.030)	-0.030 (.020)
Some college	0.013 (.010)	0.004 (.013)	0.088*** (.017)	0.035 (.032)	-0.046* (.025)
College graduate	0.038*** (.010)	0.018 (.015)	0.122*** (.019)	0.039 (.039)	-0.034 (.033)
Employed	0.014*** (.005)	-0.005 (.009)	-0.004 (.010)	0.004 (.021)	-0.012 (.017)
\$10,000-\$14,999 HH income	-0.009 (.016)	-0.002 (.016)	-0.009 (.019)	-0.021 (.034)	-0.002 (.027)
\$15,000-\$19,999 HH income	0.013 (.013)	0.028* (.014)	0.029* (.017)	0.008 (.028)	0.030 (.026)
\$20,000-\$24,999 HH income	0.018 (.013)	0.040 (.014)	0.035* (.018)	0.032 (.031)	0.036 (.027)
\$25,000-\$34,999 HH income	0.034* (.013)	0.033** (.016)	0.036* (.019)	-0.014 (.036)	0.019 (.029)
\$35,000-\$49,999 HH income	0.053*** (.013)	0.010 (.021)	0.016 (.025)	0.021 (.050)	0.004 (.042)
\$50,000-\$74,999 HH income	0.092*** (.013)	0.069 (.054)	0.120*** (.052)	0.076 (.110)	-0.119 (.124)
\$75,000 or more HH income	0.118*** (.013)	-0.055 (.103)	0.039 (.124)	0.333** (.169)	-0.150 (.230)
Black, non-Hispanic	0.071*** (.008)	0.124*** (.012)			
Other race, non-Hispanic	-0.088*** (.012)	-0.046** (.021)			
Multiracial, non-Hispanic	0.000 (.019)	0.056* (.031)			
Hispanic	0.052*** (.008)	0.093*** (.012)			
Mean screening rate (%)	69.2	63.2	58.8	70.0	67.7
N(unweighted)	202,068	64,307	41,515	6,690	11,237
N(weighted)	689,685	689,526	689,095	610,414	665,630

Notes. All models also include state and year fixed effects. All analyses are weighted to account for the complex sample design of the BRFSS. Standard errors in parentheses. *** $p < .01$, ** $p < .05$, * $p < .1$.

women, for whom expansions in Medicaid are associated with a 13.4 percentage point increase in the receipt of a Pap test. This is also the group that experienced the largest coverage increases as a result of expansions. DD estimates of the impact of expansion on coverage indicate a 4.0 percentage point increase among all low-income women in health insurance coverage as a result of expansions and an 8.1 percentage point increase among low-income Hispanic women (see Table 1 in Appendix SA4).

Results are robust to the inclusion of a control for the presence of state Medicaid family planning waivers (see Table 1 in Appendix SA5). For the sample of all women, the coefficient declines slightly to 0.010 and is no longer marginally significant. Among low-income women, both overall and by race/ethnicity, the magnitude and significance of the results are robust to the inclusion of the control for family planning waivers.

Simulated Eligibility Results

Table 5 presents estimates of the effect of Medicaid expansion on cervical cancer screening based on the simulated eligibility models. As in the DD models, we find evidence of a statistically significant positive association between cervical cancer screening among low-income women and Medicaid simulated eligibility. The results suggest that a 10 percentage point increase in simulated eligibility is associated with a 1.08 percentage point increase in cervical cancer screening. To put this in context, among the expansion states included in the DD analysis, the mean change in simulated eligibility after expansion of coverage was 22 percentage points, with eligibility increases ranging from 14.1 to 33.5 percentage points. As in the DD results, the magnitude of the increase for low-income Hispanic women is more than twice that for the overall low-income sample; the estimates suggest an increase in screening of 2.2 percentage points associated with a 10 percentage point increase in simulated eligibility. All results are robust to the inclusion of a control for state family planning waivers (see Table 2 in Appendix SA5).

DISCUSSION

We consider the effect of Medicaid expansions to nonelderly adults on cervical cancer screening and find evidence of increases in screening among low-income women targeted by the expansions. Our results parallel findings regarding the impact of health insurance coverage on receipt of cervical

Table 5: Models of Effect of Simulated Medicaid Eligibility on Receipt of Pap Tests

	<200 FPL				
	All Income Levels	Overall	White Non-Hispanic	Black Non-Hispanic	Hispanic
Simulated eligibility	0.0023 (.000)	0.0108** (.001)	0.0072 (.001)	−0.0138 (.001)	0.0220* (.001)
Age	−0.0037*** (.000)	−0.0052*** (.000)	−0.0061** (.000)	−0.0057*** (.000)	−0.0037*** (.001)
Married	0.0364*** (.003)	0.0272*** (.005)	0.0158** (.006)	−0.0105 (.012)	0.0544*** (.012)
High school graduate	0.0102* (.006)	0.009 (.007)	0.0511*** (.010)	0.0456*** (.015)	−0.0115 (.013)
Some college	0.0262*** (.006)	0.0142* (.008)	0.0712*** (.010)	0.0369*** (.016)	−0.0459*** (.017)
College graduate	0.0573*** (.006)	0.0336*** (.009)	0.1056*** (.011)	0.0393** (.011)	−0.0074 (.021)
Employed	0.0126*** (.006)	−0.0053 (.005)	−0.0099* (.006)	0.0031 (.011)	−0.0139 (.012)
\$10,000–\$14,999 HH income	−0.0047 (.009)	0.0033 (.009)	−0.0065 (.011)	0.0046 (.017)	0.0107 (.020)
\$15,000–\$19,999 HH income	0.0126 (.008)	0.0256*** (.008)	0.0172 (.011)	0.0277* (.015)	0.0319* (.019)
\$20,000–\$24,999 HH income	0.0256*** (.008)	0.0439*** (.008)	0.0390*** (.011)	0.0579*** (.016)	0.0400*** (.019)
\$25,000–\$34,999 HH income	0.0477*** (.008)	0.0473*** (.009)	0.0521*** (.011)	0.0321* (.018)	0.0356* (.021)
\$35,000–\$49,999 HH income	0.0799*** (.008)	0.0493*** (.012)	0.0517*** (.014)	0.0806*** (.026)	0.0389 (.030)
\$50,000–\$74,999 HH income	0.1126*** (.008)	0.0276 (.033)	0.0336 (.035)	0.0809 (.088)	−0.0889 (.094)
\$75,000 or more HH income	0.1509*** (.008)	0.0820 (.064)	0.1176 (.074)	0.3112*** (.048)	−0.0604 (.154)
Black, non-Hispanic	0.0760*** (.004)	0.1262*** (.006)			
Other race, non-Hispanic	−0.0914*** (.007)	−0.0374*** (.013)			
Multiracial, non-Hispanic	−0.0069 (.012)	0.0388** (.019)			
Hispanic	0.0470*** (.005)	0.0904*** (.007)			
Mean screening rate (%)	69.4	62.1	58.4	69.6	65.4
N (unweighted)	549,226	172,266	107,649	28,057	25,799
N (weighted)	1,871,529	1,871,283	1,870,683	1,702,050	1,822,659

Notes: All models also include state and year fixed effects. All analyses are weighted to account for the complex sample design of the BRFSS. Standard errors in parentheses. *** $p < .01$, ** $p < .05$, * $p < .1$.

cancer screening from a number of other contexts. Findings from the Oregon Health Insurance Experiment suggest an intent-to-treat estimate of 5.1 percentage points when considering changes in Pap tests in the first year of the experiment (Finkelstein et al. 2012). Estimates from Massachusetts health reform show a 4.7 percentage point increase in Pap tests overall and approximately 6 percentage points among low-income women (Sabik and Bradley 2016). In the context of private health insurance, state mandates increase annual Pap tests by 1.1 percentage points overall and by 5.2 percentage points among Hispanic women (Bitler and Carpenter 2017).

Using expansions across multiple states also allows us to assess how results compare to studies focused on only one or a small number of expansion states. Heterogeneity in income eligibility thresholds and variation in the timing of expansions, as well as waivers allowing for more limited expansions and state programs funding public insurance, make it difficult to neatly categorize states for the purpose of comparison. Our use of two complementary methodological approaches allows us to produce estimates of the impact of expansion, regardless of the magnitude of the particular expansion, as well as an estimate of the impact of incremental increases in Medicaid eligibility generosity. Our results suggest that earlier findings from the context of single states or higher-income women generalize to Medicaid expansions impacting low-income women across a number of states.

Cervical cancer screening increases after state-level expansions of Medicaid eligibility to nonelderly adults, despite the presence of other programs that cover or provide cervical cancer screening, including Medicaid waiver programs and state NBCCEDP programs. Our findings suggest that despite the positive impacts of family planning programs and the NBCCEDP (Wherry 2013b; Lantz and Mullen 2015; Nikpay 2016), comprehensive insurance coverage intended to link women to primary care may further increase access to preventive services. On the other hand, the NBCCEDP is a targeted program (Adams, Breen, and Joski 2007; Tangka et al. 2010), and a broader screening-specific program may lead to greater increases in screening.

This study has limitations. First, over the time period we study, the BRFSS used a landline-only telephone sampling frame, which may limit representativeness of the study. We utilize the complex survey weights in all analyses to ameliorate potential bias arising from sampling, but the landline-only frame remains a limitation. Second, while self-reported measures of women's cancer screening in the BRFSS have been validated (Zapka et al. 1996; Caplan et al. 2003), there is evidence of over-reporting of screening, particularly among minorities (Fiscella et al., 2006; Njai et al. 2011). We do not

expect reporting to vary systematically with state Medicaid eligibility policy, so this tendency should not bias our estimates of changes in screening rates, but it may impact estimates of average screening rates overall and across subgroups. Third, income information in the BRFSS is collected in categories, so there is some imprecision in income measures used to categorize our sample. Fourth, we focus on annual screening, even though guidelines changed over this period to recommend less frequent screening. Thus, the impact on guideline concordant screening receipt may be greater than our estimates of the effects on annual screening. Fifth, our results may not generalize to other screening and preventive care services, some of which target different populations and may entail more barriers to access than cervical cancer screening.

Our results indicate that cervical cancer screening increased among low-income women in expansion states relative to control states after increases in Medicaid eligibility. The ultimate goal of increasing screening is to reduce mortality from cervical cancer, a disease that can be prevented with regular screening and removal of precancerous lesions. It is difficult to translate our estimates of the effects of Medicaid expansions on annual screening among low-income women into expected life-years saved for a few reasons: We estimate multiple models on different groups of states and produce a range of estimates; we examine annual screening (rather than guideline-recommended screening, which varies based on organization and year); our effects are relevant for a specific population of Medicaid-eligible women and eligibility guidelines differ across states; and the existing literature on the health effects of screening in the United States may not generalize to the population we study. Nonetheless, given estimates of the impacts of screening on lives saved from similar contexts (Ekwueme et al. 2014), our findings that Medicaid expansions are associated with significant increases in screening for low-income women suggest expansions may reduce mortality from cervical cancer.

We find that Medicaid expansions improved preventive care along a key measure that is important for early cancer detection and prevention of cancer morbidity and mortality. An avenue for future research is to explore the effects of Medicaid expansions on related health outcomes, including stage at cancer diagnosis and incidence of advanced-stage cancers. Increases in screening should detect disease at earlier stages, leading to improvements in health outcomes and potential cost savings. There have been many policy proposals regarding potential changes to Medicaid at the state and federal levels. Our results demonstrate that increasing nonelderly adult eligibility increases use of an important preventive health care service, with the largest increase among

Hispanic women, a group that has historically had higher incidence of cervical cancer than other racial and ethnic groups in the United States (Centers for Disease Control and Prevention 2016). Our findings are particularly important in light of updated estimates, suggesting that cervical cancer mortality rates and racial disparities in cervical cancer mortality are greater than previously thought (Beavis, Gravitt, and Rositch 2017). Our findings suggest that expanding full health insurance coverage may be an effective means to increasing screening.

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NOTE

1. We do not control for health insurance coverage in the regressions as we expect this is the main mechanism through which Medicaid expansions will impact screening.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the supporting information tab for this article:

Appendix SA1: Author Matrix.

Appendix SA2: Sources of Information on State Medicaid Eligibility Thresholds.

Appendix SA3: Expansions of Adult Medicaid Eligibility, 2000–2010.

Appendix SA4: Changes in Health Insurance Coverage for Low-Income Women.

Table 1. Difference-in-Differences Models of Effect of Medicaid Expansion on Health Insurance Coverage for Low-Income Women Overall and by Race/Ethnicity.

Table 2. Models of Effect of Simulated Medicaid Eligibility on Health Insurance Coverage for Low-Income Women Overall and by Race/Ethnicity.

Appendix SA5: Sensitivity Analysis Controlling for Family Planning Waivers in Regression Models.

Table 1. Difference-in-Differences Models of Effect of Medicaid Expansion on Receipt of Pap Tests with Control for Family Planning Waivers.

Table 2. Models of Effect of Simulated Medicaid Eligibility on Receipt of Pap Tests with Control for Family Planning Waivers.