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Association of State-level Medicaid Expansion, Prostate Cancer Incidence and Insurance Status: A Multivariable Logistic and Joinpoint Regression Analysis, SEER 2012–2014

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Abstract

Association of State-level Medicaid Expansion, Prostate Cancer Incidence and Insurance Status: A Multivariable Logistic and Joinpoint Regression Analysis, SEER 2012–2014

By Wen Liu

Introduction

The Affordable Care Act (ACA) expanded health insurance coverage in the United States in multiple ways, including through voluntary state-based provision of Medicaid. We evaluated the association between Medicaid expansion and prostate cancer incidence, hypothesizing that increased access would be associated with increased prostate cancer incidence.

Methods

Using data from the Surveillance Epidemiology and End Results (SEER) program (2012–2014), we identified men 40+ years of age newly-diagnosed with prostate cancer. We determined quarterly prostate cancer incidence and compared this outcome between states that did and did not expand Medicaid coverage. Using joinpoint regression, we estimated trends in age-adjusted prostate cancer incidence and examined annual percent change (APC) over time by stage of disease. We also generated a multivariable model which adjusted for patient-level sociodemographic factors and estimated individual-level odds of prostate cancer diagnosis based on residence in a Medicaid expansion state.

Results

We identified 142,082 prostate cancer patients (mean age 66.1±9.0 years) diagnosed between January 1, 2012 and December 31, 2014. In non-expansion states, more men were Black (31.0% vs. 11.0%), uninsured (2.3% vs. 1.3%), and less commonly covered by Medicaid (4.5% vs. 5.2%) (all $p<0.001$). In 2014, residence in an expansion state was associated with increased likelihood of Medicaid coverage (RR 1.20, 95% CI 1.14–1.27) and lower odds of being uninsured (OR 0.48, 95% CI 0.43–0.54). Overall prostate cancer incidence decreased over time (APC -0.80%) in non-expansion states. In men ages 40-64 years, overall prostate cancer incidence decreased in both expansion and non-expansion states (APC -0.83% expansion states, -0.53% non-expansion) (both $p < 0.001$). We did not observe a clear relationship between Medicaid expansion and changes in incidence of prostate cancer across all stages. There was a monotonic decrease in localized disease of -0.54% to -0.40% interrupted by a sharper decline from June–September 2013 (APC -4.34%). Incidence of nodal disease increased (APC 0.68%) while regional and metastatic disease incidence remained relatively unchanged (APC -0.34%, 0.10%, respectively).

Conclusions

Despite increased Medicaid coverage, trends in prostate cancer incidence do not appear to be influenced by Medicaid expansion, though effects of Medicaid expansion may be delayed beyond one year.

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Introduction

Though there have been significant advances in medicine and technology over the past century, considerable inequity in access to health care services persists. The Patient Protection and Affordable Care Act (ACA) increased health insurance coverage in many ways, including expanding Medicaid eligibility at the state-level. The ACA implementation took effect on January 1, 2014 and allowed coverage for low-income childless adults under 65 years of age whose household income was at or below 133 percent of the federal poverty level. To date, over 20 million previously uninsured individuals have gained health care coverage with the proportion of the population without health insurance at a historic low.[1,2] Prior research has shown that in states that expanded Medicaid pre-ACA, newly covered individuals were disproportionately minorities, older, in poorer health and more likely to delay care due to cost.[3-5] It was also shown that racial disparities in all-cause mortality were reduced following increased insurance coverage.[1,4,6] Early findings after ACA implementation indicate significant reductions in the proportion of uninsured among the poor and among those who live in Medicaid expansion states,[5,6] along with increased insurance coverage and health care utilization for low-income adults.[7]

In general, survival after a cancer diagnosis has improved significantly in the past two decades. However, disparities by race and ethnicity,[8] and socioeconomic status[9] still exist. These disparities are driven, at least in part, by a lack of health insurance, which affects the receipt of preventive services and screening,[10] impacting overall health, financial stability and mortality.[11] Uninsured patients have lower rates of cancer screening and higher rates of advanced malignancies.[12-17] As an example, poor women living in states that did not expand Medicaid demonstrated lower breast and cervical cancer screening rates.[18]

Medicaid expansion may open doors for at-risk men who otherwise wouldn't undergo prostate cancer screening. Though the United States Preventative Services Task Force (USPSTF) ruled against routine PSA screening in 2012, multiple guidelines emphasize the importance of discussing the risks and benefits of PSA screening, particularly among men at higher risk (e.g., Black men).[19,20] In early expansion states, there was a 3% absolute increase in screening among men earning less than 138% of the federal poverty level, men 55 to 59 years, and Black and Hispanic men.[21] However, it is unknown what effect Medicaid expansion on a larger scale may have on prostate cancer incidence. We hypothesized that, by increasing access to health care, Medicaid expansion would be associated with a greater prostate cancer incidence overall and across disease stages (i.e., localized, regional, and distant).

Methods

Dataset

We used data from the Surveillance, Epidemiology and End Results (SEER) Program (National Cancer Institute, Bethesda, MD) from January 2012 through December 2014.[22] The SEER program provides information on cancer statistics with selected demographic and tumor-specific factors. The 18 cancer registries that report to SEER cover approximately 28% of the U.S. population.[23]

Study Population

We identified men aged 40 years and older newly diagnosed with prostate cancer from 2012–2014. We then excluded non-histologically confirmed cases, men residing in the Alaska SEER Registry (as results from the Native American population may not be generalizable broadly), and cases from autopsy/death certificate reporting. The final study population consisted of 142,082 men with a new prostate cancer diagnosis from 12 states. Supplementary Table 1 lists the selection criteria for inclusion in the study.

Exposures and Outcomes

State-level analysis

The primary exposure was state Medicaid expansion status. As of February 2018, 33 states (including DC) have adopted Medicaid Expansion, and states with SEER registries that adopted Medicaid expansion include California, Connecticut, Hawaii, Iowa, Kentucky, Michigan (expanded April 1, 2014), New Jersey, New Mexico, and Washington. Those that did not expand or expanded later include Georgia, Utah, and Louisiana (expanded July 1, 2016). The primary outcomes were annual age-adjusted prostate cancer incidence (per 100,000 men over 40 years of age) and change in incidence over time. Age-adjusted rates were based on the 2000 U.S. standard

population calculated with SEER*Stat software (version 8.3.5). State-level socioeconomic characteristics included percentage of persons with less than high school education, percentage of persons below poverty, level of unemployment and median household income (Supplementary Table 2).

Patient-level analysis

At an individual level, the exposure was residence in a Medicaid expansion state. Other patient-level covariates of interest included year of diagnosis, age group (40–64 vs. 65+ years), race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, and Other, including Asian/Pacific Islander and unknown using SEER Race Recode and Origin Recode NAACCR Hispanic Identification Algorithm variables), marital status (single, married, separated/divorced/widowed), insurance status (uninsured, Medicaid, insured), Grade Group (Gleason score), PSA, tumor TNM stage (based on American Joint Committee on Cancer 7th edition [AJCC]), AJCC stage, SEER summary stage, and stage of disease (localized, regional, nodal, or distant metastatic [hereafter referred to as metastatic]). Grade Group was based on the updated International Society of Urological Pathology (ISUP) system: Grade Group 1 (Gleason score <6), Grade Group 2 (Gleason score 3+4=7), Grade Group 3 (Gleason score 4+3=7), Grade Group 4 (Gleason score 8), and Grade Group 5 (Gleason scores 9-10).[24] Stage of disease was categorized as localized (T1-T2, N0, M0), regional (T3-T4, N0, M0), nodal (any T, N1, M0); and metastatic (any T, any N, M1).

Statistical Analysis

State-level

Socioeconomic characteristics were compared using medians and interquartile ranges between expansion and non-expansion states with statistical significance determined by t-tests for continuous variables. Incidence trends over the entire interval of interest were examined by fitting

a weighted least-squares regression line to the natural logarithm of the rates where the independent variable was the monthly interval. The results of these joinpoint analyses were expressed as annual percent change (APC) and the corresponding 95% confidence intervals (CI). The presence of changes in trend (inflection points) was tested using a Monte Carlo Permutation method.[25] The models allowed for a maximum of 5 inflection points, and the final model was selected based on the best fit.

Patient-level

We performed bivariate analyses to evaluate associations between residence in a Medicaid expansion state in 2014 (versus a non-expansion state) and various demographic and clinical patient characteristics. Multivariable logistic regression analyses were conducted to examine the association between exposure to Medicaid expansion and the likelihood of being diagnosed with more advanced disease, controlling for age, race/ethnicity, insurance, and marital status. The main exposure variable included three categories: residence in a non-expansion state from 2012–2014, residence in an expansion state prior to 2014, and residence in an expansion state after 2014. The stage at diagnosis was dichotomized (early versus late stage disease) based on different staging systems: 1) AJCC stage I/II versus AJCC stage III/IV disease, 2) SEER summary stage localized versus regional/distant, and 3) coded stage localized versus regional/nodal/metastatic, respectively. The results of the logistic regression analyses were expressed as adjusted odds ratios (aOR) and the corresponding 95% confidence intervals (CI).

All analyses were performed using SAS 9.4 (SAS Institute, Cary, NC) or Joinpoint Regression Program 4.5.0.1 (Statistical Research and Applications Branch, U.S. National Cancer Institute). Two-sided $p < 0.05$ was considered statistically significant for all analyses.

Results

State-level Analyses

Socioeconomic Characteristics

We identified 142,082 men (mean age 66 years) diagnosed with histologically confirmed prostate cancer between January 1, 2012 and December 31, 2014 (Table 1). There were 112,163 cases (78.9%) diagnosed in expansion states and 29,919 (21.1%) in non-expansion states. The characteristics of men with prostate cancer in states that instituted Medicaid expansion in 2014 differed from those in non-expansion states in several aspects. In states that did not expand Medicaid in 2014, there was a higher percentage of residents living below poverty (17.6% vs. 13.2%), lower unemployment rate (8.3% vs. 8.8%), and lower median household income ($49,290 vs. $59,950) (Supplementary Table 2). On the other hand, the proportion of people who had lower than a high school education was similar in expansion and non-expansion states (13.0% vs. 13.7%, respectively).

Joinpoint Regression: Incidence in Men Over 40 Years

Age-adjusted prostate cancer incidence was 238.49 per 100,000 men across all SEER registries overall (data not shown). Incidence was greater in non-expansion states (267.97 vs. 242.93 per 100,000 men in expansion states) and decreased over time from 2012 to 2014 with an APC of -0.61% in non-expansion states and -0.84% in expansion states (both p-values < 0.001) (Figure 1a). No significant inflection points were observed in disease stage subgroups, with localized and regional disease decreasing in rate (APCs ranging from -0.02% to -1.06%) (Figures 1b, c) and nodal and metastatic disease increasing in rate (APC 0.77%, $p < 0.001$; 0.10%, $p = 0.43$, respectively) (Figures 1d, e).

Joinpoint Regression: Incidence in Men Ages 40–64

In this younger age group, there was a statistically significant decrease in overall prostate cancer incidence from 2012–2014 with an APC of -0.83% in expansion and -0.53% in non-expansion states (both $p < 0.001$) (Figure 2a). The decrease in incidence of localized disease ranged from 0.54% ($p = 0.03$) to 0.40% ($p = 0.24$) and the decline appeared to be sharper from June 2013 through September 2013 (APC -4.34%, $p = 0.56$) (Figure 2b). There were no significant changes in incidence based on expansion status in regional, nodal or metastatic disease. In general, incidence rates declined for regional disease (APC -0.34%, $p = 0.01$) (Figure 2c) but increased for nodal and metastatic disease (APC 0.94%, $p < 0.001$; 0.34%, $p = 0.11$, respectively) (Figures 2d, e).

Joinpoint Regression: Incidence in Men Ages 65+

In the Medicare-eligible population, overall cancer incidence decreased by -0.82% annually across all states ($p < 0.001$) (Figure 3). The incidence trends are similar to those of the younger population, with decreases for localized and regional disease (APCs -1.01%, -0.36%, respectively; $p < 0.001$, $p < 0.01$) (Figures 3b, c) and increased rates for nodal and metastatic disease (APC 0.56%, $p = 0.029$; 0.04%, $p = 0.81$, respectively) (Figures 3d, e). The time trends did not differ in expansion and non-expansion states.

Patient-level Analyses

Sociodemographic characteristics

Out of 142,082 men, the majority (79.7%) were diagnosed with prostate cancer between ages 50 and 74 years, with 40.5% of men who were 40 to 64 years of age and 56.9% of patients in the Medicare-eligible age group over 65 years of age (Table 1). In non-expansion states, a larger proportion of men were non-Hispanic Black (31.0% vs. 11.0% non-Hispanic White) and

uninsured (2.3% vs. 1.3% insured), with lower Medicaid coverage in those states overall (4.5% vs. 5.2% in expansion states) ($p < 0.0001$).

Tumor Characteristics

The majority of cases overall were assigned Grade Groups 1 or 2 (61.7% in expansion and 63.8% in non-expansion states), with a higher proportion of Grade 4 or 5 disease in expansion states (19.4%) compared to non-expansion states (17.4%). Half of the men (50.0%) had prostate specific antigen (PSA) levels between 4.0 and 9.9 ng/ml, and more men in non-expansion states had PSA levels under 4.0 ng/ml (21.2% vs. 9.6% expansion). Most patients had stage T1–T2 disease (81.9% in expansion states, 87.9% in non-expansion), N0 (87.3% expansion, 92.7% non-expansion), and M0 (94.6% expansion, 95.2% expansion). The number of cases classified as localized, regional, nodal, and metastatic were 113,254, 13,000, 2,777, and 7,524, respectively.

Medicaid Expansion and Insurance Status

The probability of having Medicaid coverage was 20% higher for men living in states that expanded Medicaid in 2014 than for individuals living in non-expansion states from 2012–2014 (prevalence ratio [PR] 1.20, 95% CI 1.14–1.27). Men living in expansion states in 2014 were half as likely to be uninsured compared with those who did not live in an expansion state or lived in an expansion state prior to 2014 (PR 0.48, 95% CI 0.43–0.54). In 2014 only, men living in expansion states were more likely to have Medicaid and less likely to be uninsured (PR 1.24, 95% CI 1.12–1.38; PR 0.38, 95% CI 0.32–0.45, respectively).

Predictors of Advanced Disease

Using AJCC 7th edition staging, 17.6% of all cases were late stage compared to 19.0% of cases using the derived SEER summary stage coding and 17.1% using manually coded stages. Multivariable logistic regression models demonstrated that relative to patients diagnosed in a non-

expansion state, those diagnosed in an expansion state in 2014 were more likely to be diagnosed with more advanced disease (aOR 1.44, 95% CI 1.37–1.51, $p < 0.0001$) (Table 2). The range of increase was similar across different staging variables used (AJCC, SEER summary stages, or manually coded) (aOR 1.44, 1.32, 1.42, respectively; all $p < 0.0001$). Within AJCC stages, men who were Hispanic or other race/ethnicities were more likely to be diagnosed with late-stage disease (aOR 1.11, 95% CI 1.05–1.17; aOR 1.14, 95% CI 1.07–1.22 vs. non-Hispanic White, respectively), while non-Hispanic Black men, married men, and those with non-Medicaid coverage were less likely to have Stage 3 or 4 prostate cancer (aOR 0.87, 95% CI 0.83–0.91, aOR 0.87, 95% CI 0.84–0.90, aOR 0.59, 95% CI 0.54–0.66, respectively).

Discussion

This analysis evaluating the population-level effect of Medicaid expansion on prostate cancer incidence from 2012–2014 found that rates overall are decreasing in localized and regional subgroups but increasing in nodal and metastatic disease. We observed an association between living in a Medicaid expansion state in 2014 and increased Medicaid coverage, lower uninsured rates, and increased likelihood of late-stage prostate cancer at diagnosis. Although significant changes in rates were detected in joinpoint models for localized disease in men ages 40–64, the pattern does not appear to be temporally related to Medicaid expansion rollout in January 2014. The sociodemographic composition of men living in expansion and non-expansion states is varied, with higher proportions of non-Hispanic Black men as well as more poverty in non-expansion states.

The decline in age-adjusted incidence rates of prostate cancer seen in this study is consistent with previously described national trends of prostate cancer in the United States.[26-28] The decreasing incidence may be related to the 2011 USPSTF draft recommendation against screening regardless of age. Furthermore, current clinical practice has been aimed at limiting overdiagnosis and subsequent overtreatment to reduce morbidity and mortality associated with cancer treatments. Though the joinpoint regression analyses appear to suggest that changes in prostate cancer incidence are not attributable to Medicaid expansion, these results may reflect the delay in accessing and receiving care even after obtaining health insurance. One year of data after the ACA provisions went into effect is unlikely to adequately capture the lasting impact of increased coverage, especially given the logistical difficulties and varied implementation of Medicaid expansion amongst substantial heterogeneity in state policies, Health Insurance Marketplaces, health systems, and patient populations. Even with a completely smooth rollout, it is quite possible that any effects may be washed out by this variability, especially in the earliest period of time after new policies are put in place.

Recently, Jemal et al.[29] used SEER data to assess incidence rates for localized prostate cancer following the USPSTF recommendations against routine PSA testing in all men in 2012. They found that prostate cancer incidence rates declined by 19% from 2011 to 2012 and by 6% from 2012 to 2013 without changes in rates of distant disease, with PSA testing rates decreasing significantly from 36.8% to 29.9% in men 50 to 74 years old and 43.1% to 36.3% in men 75 years and older. In contrast, Hu et al.[30] found an increase in the proportion of men presenting with distant metastases and clinically significant prostate cancer reported by SEER from 2004 to 2013, which was also observed in our present study. There will likely be further changes in these trends given the recent softening of USPSTF's position on PSA screening to support an individualized decision-making process between patients and clinicians.[20]

In addition, time to accessing care, diagnosis and treatment received after obtaining insurance coverage can be significantly prolonged for those who have been otherwise underserved. Though non-Hispanic Black men appeared not to be more likely to present with advanced disease in our study population, outcomes are widely disparate. Schmid *et al*.[31] found evidence of a substantial difference in quality of surgical care for prostate cancer in Black patients, with not just longer treatment delay but also lower likelihood of receiving radical prostatectomy within three months of diagnosis compared to non-Hispanic white men. Weiner *et al*.[32] found that men younger than 65 years of age with nonpalpable prostate cancer were more likely to receive conservative management if they were Black and had no insurance—or even if they did have state Medicaid coverage—than if they had private insurance. Other studies echo these findings, with those having private insurance more likely to receive guideline treatments compared to those with Medicaid, an effect that is more pronounced for non-Hispanic Black patients.[33]

These findings may reflect the complexity of the relationship between health care coverage and clinical outcomes. It has been well-established in the literature that Medicaid expands access to cancer screening and care broadly, which may mitigate cancer-specific disparities in care.[34] Amongst a cohort of Medicare-ineligible men with high-risk prostate cancer, those who were insured were 77% less likely to present with metastatic disease and over twice as likely to receive definitive therapy if they had non-metastatic disease compared to those without insurance.[35] Insurance coverage in this cohort was associated with an over two-fold increase in receipt of definitive therapy as well as reductions in prostate cancer-specific mortality and all-cause mortality. There were also significant, more than additive, interactions between race and Medicaid coverage, and while disparities in cancer-specific mortality and metastatic disease at presentation were observed in privately insured patients, none were observed in Medicaid patients.[36] Interestingly, we observed an independent association of increased late-stage diagnoses in men living in Medicaid expansion states (though Medicaid coverage itself was not associated with increased advanced disease), and in Hispanic and other racial/ethnic groups.

Although living in a Medicaid expansion state in 2014 was associated with an increased likelihood of having Medicaid coverage and lower likelihood of being uninsured (i.e. Medicaid expansion increases insurance coverage), these changes did not appear to affect prostate cancer incidence. If analysis of more recent years of data do not reveal a discernible effect of Medicaid expansion for prostate cancer, this may be due to the fact that prostate cancer is a disease that predominantly affects the elderly (i.e., men over 65 years of age). Thus, Medicaid expansion may not have as noticeable an effect on incidence of prostate cancer as it may have on other cancers (e.g., breast cancer). However, it is nevertheless crucial to remember that the ability to successfully diagnose and treat prostate cancer in younger men has considerable impact due to the excellent survival rates. A further consideration is early-onset prostate cancer ($\leq$ 55 years of age),

a distinct clinicopathological phenotype that is thought to be more aggressive with a poorer prognosis,[37,38] in which case Medicaid coverage would indeed be more relevant.

The variable demographic and socioeconomic compositions of men residing in expansion and non-expansion states are notable. Given that prostate cancer incidence and mortality is higher in Black men, a larger proportion of Black patients residing in non-expansion states such as Georgia and Louisiana (or Alabama and Mississippi, states not covered by SEER registries) is particularly relevant as these populations already experience disparate outcomes. Sammon *et al*.[21] found that the gap in PSA screening rates between higher and lower income men in Medicaid early expansion states narrowed significantly, which may reflect better access to preventive services with increased insurance coverage. Without achieving health care access through adequate insurance coverage for low-income adult populations,[39] inequalities in outcomes cannot be completely addressed.

The 18-SEER registries represent the most current, population-level cancer registry data with a substantial sample size that enables evaluating patterns of disease occurrence. On the other hand, a notable limitation of the SEER data is lack of information on patient-level socioeconomic characteristics and on health care organizations and individual providers. It is also important to note that the results of joinpoint regression analysis considered expansion and non-expansion states as two homogenous groups, and thus did not take into consideration within-group heterogeneity. Similarly, aggregated state-level data may obscure county-level and individual clinical variation. Perhaps the most important limitation of this study is the short follow-up time with only a single year of data post-Medicaid expansion; for this reason, we intend to conduct the analysis including 2015 data as soon as they are released by the National Cancer Institute.

In light of the results from this study, it is possible that any potential effect of Medicaid expansion is masked by the delay and heterogeneity in implementation across and within states, especially in enacting out new legislation. It would be important to assess a longer period of time post-expansion to detect any changes in incidence as policies and infrastructure is built to accommodate the increase in enrollment, as coverage gains, access to care, and health benefits of expanding Medicaid increase over time.[10] Another consideration would be to examine the data from registries compiled by the North American Association of Central Cancer Registries (NAACCR), which cover 67% of the U.S. population. The use of NAACCR data would better capture nationwide trends or increase the granularity of data by using county-level rates for comparison. Lastly, despite controversy surrounding prostate cancer screening and treatment, mortality has decreased in the past two to three decades, but racial disparities have persisted.[40] It is imperative to continue dedicating efforts to improve outcomes and survival for patients who may be the most marginalized—the uninsured. Medicaid expansion has far-reaching implications beyond those of just health: maintaining a healthy workforce that can support families, communities and ultimately, the population at large, should be a priority.

Conclusions

Living in a Medicaid expansion state in 2014 is associated with increased Medicaid coverage, lower uninsured rates, and higher likelihood of presentation with late-stage prostate cancer. However, trends in prostate cancer incidence do not appear to be attributable to the immediate period following Medicaid expansion, though effects of full implementation may be delayed. Further research is needed to elucidate long-term patterns across the country in order to achieve health equity through access to care.

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Table 1. Characteristics of men diagnosed with prostate cancer (n = 142,082) stratified by state Medicaid expansion status, 2012-2014.

Covariate		Medicaid Expansion (n = 112,163)	No Medicaid Expansion (n = 29,919)	Total (n = 142,082)	p*
Patient Characteristics					
Age at Diagnosis (years)	Mean ± SD	66.3±9.1	65.4±8.8	66.1±9.0	<0.0001
	40-49	2,790 (2.49)	948 (3.17)	3,738	<0.0001
	50-54	7,845 (6.99)	2,305 (7.70)	10,150	
	55-59	15,451 (13.78)	4,369 (14.60)	19,820	
	60-64	21,551 (19.21)	6,002 (20.06)	27,553	
	65-69	26,255 (23.41)	7,007 (23.32)	33,262	
	70-74	18,327 (16.34)	4,866 (16.26)	23,193	
	75-79	11,082 (9.88)	2,602 (8.70)	13,684	
	>80	8,862 (7.90)	1,820 (6.08)	10,682	
Year of Diagnosis	2012	39,321 (35.06)	10,184 (34.04)	49,505	0.0026
	2013	37,859 (33.75)	10,174 (34.01)	48,033	
	2014	34,983 (31.19)	9,561 (31.96)	44,544	
Race/ Ethnicity[a]	Non-Hispanic White	74,519 (66.44)	19,387 (64.80)	93,906	<0.0001
	Non-Hispanic Black	12,348 (11.01)	9,262 (30.96)	21,610	
	Hispanic	10,601 (9.45)	518 (1.73)	11,119	
	Other[b]	7,177 (6.40)	367 (1.23)	7,544	
Marital Status[c]	Single	12,054 (10.75)	2,964 (9.91)	15,018	<0.0001
	Married	68,379 (60.96)	17,801 (59.50)	86,180	
	Separated/ Divorced/ Widowed	12,293 (10.96)	3,465 (11.58)	15,758	
Insurance[d]	Uninsured	1,503 (1.34)	682 (2.28)	2,185	<0.0001
	Medicaid	5,794 (5.17)	1,339 (4.48)	7,133	
	Insured	89,782 (80.05)	23,599 (78.88)	113,381	
Tumor Characteristics					
Grade Group[e]	1	42,719 (38.09)	11,520 (38.5)	54,239	<0.0001
	2	26,480 (23.61)	7,561 (25.27)	34,041	
	3	12,923 (11.52)	3,579 (11.96)	16,502	
	4	11,231 (10.01)	2,903 (9.7)	14,134	
	5	10,524 (9.38)	2,289 (7.65)	12,813	
PSA, ng/ml[f]	0.1 – 3.9	10,722 (9.56)	2,878 (21.16)	13,600	<0.0001
	4.0 – 5.9	27,208 (24.26)	8,264 (27.62)	35,472	
	6.0 – 9.9	28,321 (25.25)	7,271 (24.30)	35,592	
	10.0 – 19.9	15,079 (13.44)	3,745 (12.52)	18,824	
	20.0 – 29.9	3,627 (3.23)	952 (3.18)	4,579	
	30.0 – 49.9	2,711 (2.42)	741 (2.48)	3,452	
	50.0 – 97.9	2,291 (2.04)	611 (2.04)	2,902	
	> 98.0	3,830 (3.41)	1,003 (3.35)	4,833	

T Stage[g]	T1–T2	91,824 (81.87)	26,303 (87.91)	118,127	<0.0001
	T3	12,348 (11.01)	2,568 (8.58)	14,916	
	T4	1,318 (1.18)	339 (1.13)	1,657	
N Stage[h]	N0	97,908 (87.29)	27,726 (92.67)	125,634	<0.0001
	N1	4,046 (3.61)	799 (2.67)	4,845	
	NX	10,156 (9.05)	1,383 (4.62)	11,539	
M Stage[h]	M0	106,022 (94.57)	28,472 (95.20)	134,494	<0.0001
	M1	6,088 (5.43)	1,436 (4.80)	7,524	
Metastases at Diagnosis[i]	No	98,915 (88.19)	27,626 (92.34)	126,541	<0.0001
	Yes	6,094 (5.43)	1,436 (4.80)	7,530	
Stage of Disease[j]	Localized	87,985 (64.43)	25,269 (85.80)	113,254	<0.0001
	Regional	10,709 (7.84)	2,291 (7.78)	13,000	
	Nodal	2,322 (2.17)	455 (1.54)	2,777	
	Metastatic	6,088 (5.68)	1,436 (4.88)	7,524	
AJCC Stage of Disease[k]	I	26,809 (26.10)	8,039 (28.12)	34,848	<0.0001
	IIa	24,086 (23.45)	7,712 (26.97)	31,798	
	IIb	32,835 (31.97)	8,697 (30.42)	41,532	
	III	10,169 (9.90)	2,137 (7.47)	12,306	
	IV	8,812 (8.58)	2,005 (7.01)	10,817	
SEER Summary Stage[l]	Localized	86,023 (80.28)	24,596 (83.49)	110,619	<0.0001
	Regional	14,982 (13.93)	3,416 (11.59)	18,398	
	Distant Sites	6,143 (5.73)	1,449 (4.92)	7,592	

*The parametric p-value is calculated by t-test for numerical covariates and chi-square test for categorical covariates. Abbreviations: SD – standard deviation; PSA – prostate specific antigen; IQR – interquartile range; CI – confidence interval; AJCC – American Joint Committee on Cancer 7th edition; SEER – Surveillance and End Results program

[a]Missing 7,903 (7,518 expansion, 385 non-expansion). These categories were created using SEER Race Recode and Origin Recode NAACCR Hispanic Identification Algorithm variables.
[b]Race/ethnicity "Other" category includes Asian/Pacific Islander, American Indian, and Other.
[c]Missing 25,126 (19,437 expansion, 5,689 non-expansion)
[d]Missing 19,383 (15,084 expansion, 4,299 non-expansion)
[e]Missing 10,353 (8,286 expansion, 2,067 non-expansion)
[f]Missing 22,828 (18,374 expansion, 4454 non-expansion)
[g]Missing 7,382 (6673 expansion, 709 non-expansion)
[h]Missing 64 (53 expansion, 11 non-expansion)
[i]Missing 8,011 (7,154 expansion, 857 non-expansion)
[j]Missing 5,527 (5059 expansion, 468 non-expansion). Localized disease was classified as T1-T2, N0, M0; regional as T3-T4, N0, M0; nodal as any T, N1, M0; and metastatic as any T, any N, M1.
[k]Missing 10,781 (9,452 expansion, 1,329 non-expansion)
[l]Missing 5,473 (5,015 expansion, 458 non-expansion). Regional disease includes regional by direct extension only, regional lymph node(s) only, regional by both direct extension and regional lymph node(s), regional NOS. Distant includes distant sites and/or lymph nodes.

Table 2. Estimated odds of late stage prostate cancer at diagnosis (2012–2014) using AJCC staging upon multivariate analyses of residence in Medicaid expansion state before and after ACA implementation in 2014.

Covariate		Unadjusted OR (95% CI)	Adjusted OR** (95% CI) *n* = 103,408 men
Residence in State[a]	Non-expansion State*	-	-
	Expansion State Pre-2014	1.25 (1.21 – 1.30)	**1.19 (1.14 – 1.24)**
	Expansion State Post-2014	**1.53 (1.47 – 1.60)**	**1.44 (1.37 – 1.51)**
Age Groups (years)[b]	40-54*	-	-
	55-64	1.05 (1.00 – 1.11)	1.06 (1.00 – 1.12)
	65+	0.96 (0.91 – 1.01)	1.01 (0.95 – 1.06)
Race/Ethnicity[c]	Non-Hispanic White*	-	-
	Non-Hispanic Black	**0.86 (0.83 – 0.90)**	**0.87 (0.83 – 0.91)**
	Hispanic	**1.20 (1.15 – 1.27)**	**1.11 (1.05 – 1.17)**
	Other[d]	**1.22 (1.15 – 1.30)**	**1.14 (1.07 – 1.22)**
Marital Status[e]	Single*	-	-
	Married	**0.82 (0.80 – 0.85)**	**0.87 (0.84 – 0.90)**
Insurance[f]	Uninsured*	-	-
	Medicaid	**0.99 (0.89 – 1.11)**	**0.91 (0.81 – 1.02)**
	Insured (Not Medicaid)	**0.62 (0.56 – 0.68)**	**0.59 (0.54 – 0.66)**

*Reference group. **Multivariable logistic regression with all listed covariates. Bold-faced text corresponds to $p < 0.001$. Abbreviations: SD – standard deviation; CI – confidence interval; OR – odds ratio

[a]*n* = 131,301, missing 10,781
[b]*n* = 128,032, missing 14,050
[c]*n* = 126,287, missing 15,795
[d]Race/ethnicity "Other" category includes Asian/Pacific Islander, American Indian, and Other.
[e]*n* = 112,340, missing 29,742
[f]*n* = 117,952, missing 24,130

Figure 1. Joinpoint regression models for age-adjusted prostate cancer incidence per 100,000 men older than 40 years with each interval representing one month between 2012-2014. The dotted green line represents ACA expansion in January 2014. Bold-faced APC corresponds to statistically significant APC from 0 at $p < 0.05$. Parallel regression lines are represented by the same color. **a)** All stages of prostate cancer. **b)** Localized disease. **c)** Regional disease. **d)** Nodal disease. **e)** Distant metastatic disease. Note that the y-axis scale for incidence rates are not the same. Abbreviations: ACA – Affordable Care Act; APC – annual percent change

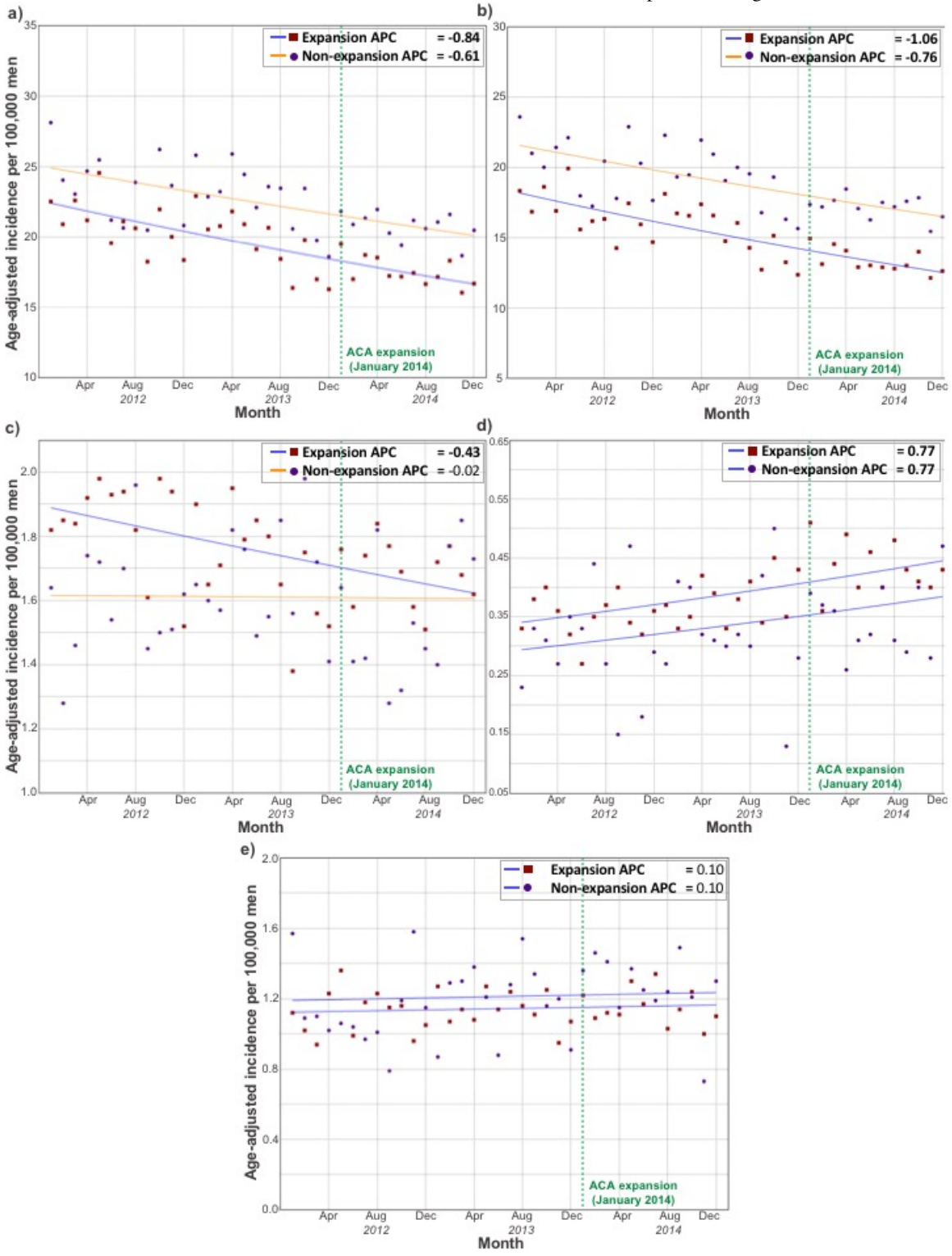


Figure 2. Joinpoint regression models for age-adjusted prostate cancer incidence per 100,000 men ages 40-64 with each interval representing one month between 2012-2014. The dotted green line represents ACA expansion in January 2014. Bold-faced APC corresponds to statistically significant APC from 0 at $p < 0.05$. Parallel regression lines are represented by the same color. **a)** All stages of prostate cancer. **b)** Localized disease with 2 joinpoints. **c)** Regional disease. **d)** Nodal disease. **e)** Distant metastatic disease. Note that the y-axis scale for incidence rates are not the same. Abbreviations: ACA – Affordable Care Act; APC – annual percent change

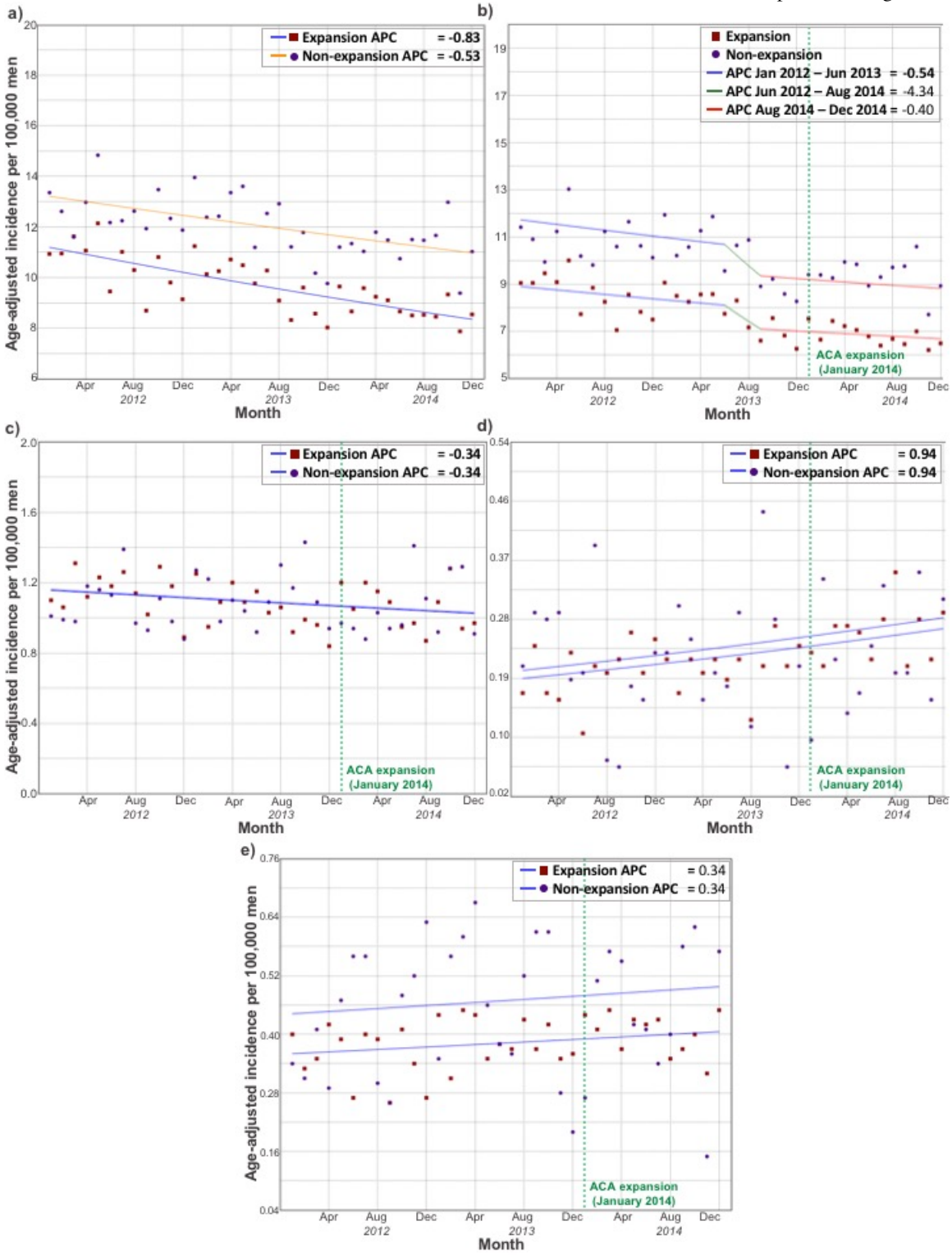
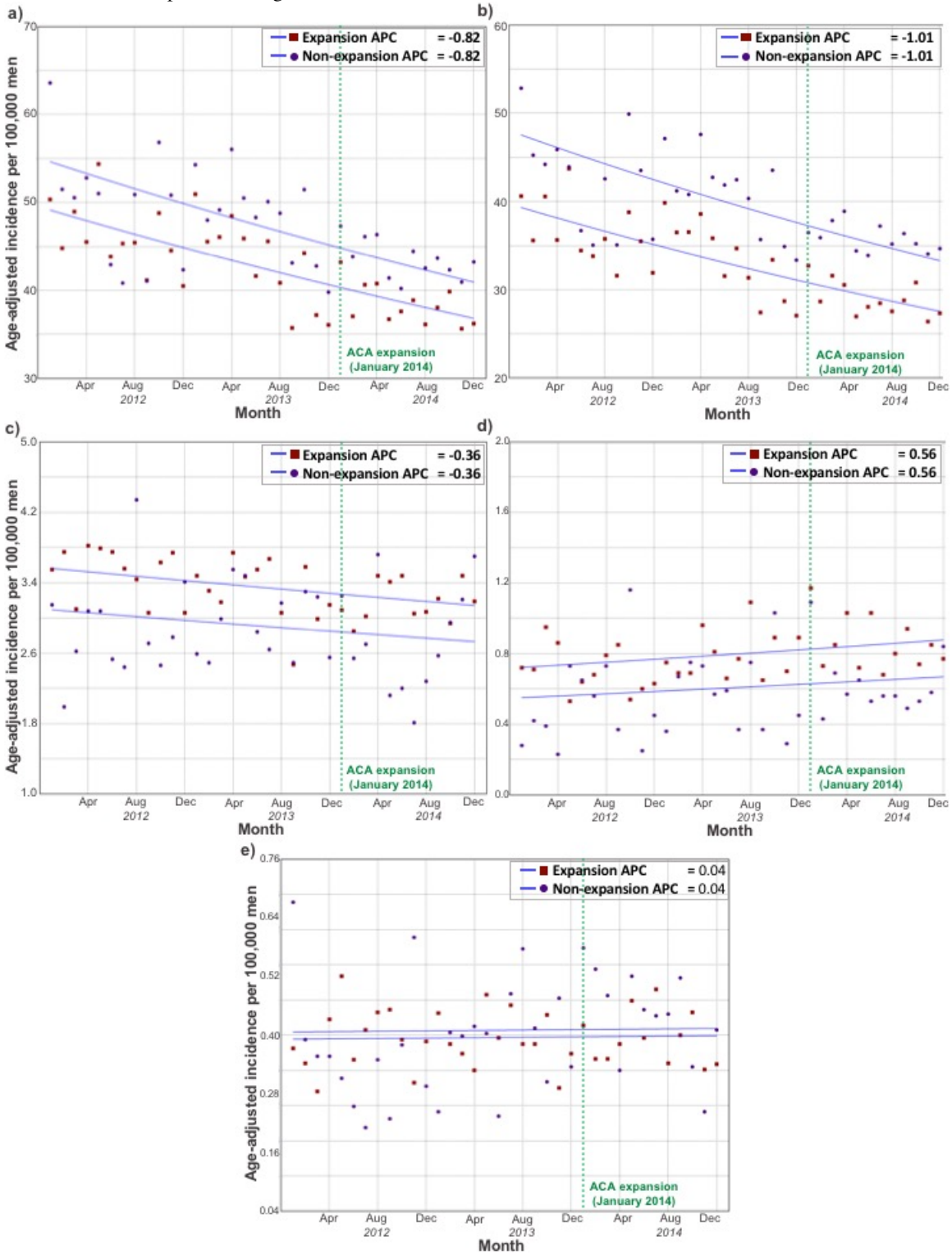


Figure 3. Joinpoint regression models for age-adjusted prostate cancer incidence per 100,000 men 65 years and older with each interval representing one month between 2012-2014. The dotted green line represents ACA expansion in January 2014. Bold-faced APC corresponds to statistically significant APC from 0 at $p < 0.05$. a) All stages of prostate cancer. b) Localized disease. c) Regional disease. d) Nodal disease. e) Distant metastatic disease. Note that the y-axis scale for incidence rates are not the same. Abbreviations: ACA – Affordable Care Act; APC – annual percent change



Supplementary Table 1. Inclusion and exclusion criteria for study population.

Eligible Patients	
Men >40 years of age with prostate cancer diagnosis (2012–2014)	*n* = 147,059
Exclude non-histologically confirmed cases	*n* = 4,846
Excluded Alaska SEER Registry	*n* = 48
Excluded autopsy/death certificate reporting	*n* = 83
Final study population	n = 142,082

Supplementary Table 2. Socioeconomic characteristics at the state level.

Covariate		**Medicaid Expansion**	**No Medicaid Expansion**	**Difference**	***p****
Socioeconomic Characteristics					
% Less than High School Education	Median (IQR)	13.02 (10.41)	13.74 (7.66)	-0.72%	<0.001
% Persons below Poverty	Median (IQR)	13.24 (7.36)	17.56 (8.24)	-4.32%	<0.001
% Unemployment Rate	Median (IQR)	8.77 (2.36)	8.30 (3.35)	0.47%	<0.001
Median Household Income	Median (IQR)	$59,950 (21,320)	$49,290 (19,490)	-$10,660	<0.001

*The parametric p-value is calculated by t-test for numerical covariates. Abbreviations: IQR – interquartile range