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Impact of the Affordable Care Act on Colorectal Cancer Screening, Incidence, and Survival in Kentucky

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Abstract

BACKGROUND: Kentucky ranks first in the US in cancer incidence and mortality. Compounded by high poverty levels and a high rate of medically uninsured, cancer rates are even worse in Appalachian Kentucky. Being one of the first states to adopt the Affordable Care Act (ACA) Medicaid expansion, insurance coverage markedly increased for Kentucky residents. The purpose of our study was to determine the impact of Medicaid expansion on colorectal cancer (CRC) screening, diagnosis, and survival in Kentucky.

STUDY DESIGN: The Kentucky Cabinet for Health and Family Services and the Kentucky Cancer Registry were queried for individuals (> 20 years old) undergoing CRC screening (per US Preventative Services Task Force) or diagnosed with primary invasive CRC from January 1, 2011 to December 31, 2016. Colorectal cancer screening rates, incidence, and survival were compared before (2011 to 2013) and after (2014 to 2016) ACA implementation.

RESULTS: Colorectal cancer screening was performed in 930,176 individuals, and 11,441 new CRCs were diagnosed from 2011 to 2016. Screening for CRC increased substantially for Medicaid patients after ACA implementation (+230%, $p < 0.001$), with a higher increase in screening among the Appalachian (+44%) compared with the non-Appalachian (+22%, $p < 0.01$) population. The incidence of CRC increased after ACA implementation in individuals with Medicaid coverage (+6.7%, $p < 0.001$). Additionally, the proportion of early stage CRC (stage I/II) increased by 9.3% for Appalachians ($p = 0.09$), while there was little change for non-Appalachians (-1.5%, $p = 0.60$). Colorectal cancer survival was improved after ACA implementation (hazard ratio 0.73, $p < 0.01$), particularly in the Appalachian population with Medicaid coverage.

CONCLUSIONS: Implementation of Medicaid expansion led to a significant increase in CRC screening, CRC diagnoses, and overall survival in CRC patients with Medicaid, with an even more profound impact in the Appalachian population.

Kentucky ranks first nationally in incidence and mortality of all site cancers.^{1,2} The Appalachian region of Kentucky heavily contributes to these poor outcomes, where cancer surpasses heart disease as the leading cause of death.^{2,3} The etiology of the disproportionately high cancer rate is multifaceted, but a major factor is the distressed socioeconomic status in Kentucky.² For the past decade, Kentucky maintained the fifth highest poverty rate in the nation.⁴ Even worse, Appalachian Kentucky has the highest poverty rate in the nation, at an astounding 1.7 times the national average. Of the 54 counties in Appalachia, 38 counties are economically distressed, or rank in the bottom 10% of all US counties.⁵

High poverty levels left a large portion of the Kentucky population uninsured and subsequently unable to seek preventative care.^{2,6-8} The Medicaid expansion of the Patient Protection and Affordable Care Act (ACA) was incredibly successful in reducing the uninsured rate in Kentucky.⁹ The expansion, enacted in 2014, provided Medicaid coverage to those at 138% of the federal poverty level (FPL). Being 1 of the first 2 states to implement the ACA, uninsured rates dropped in Kentucky by more than half, from 13.6% pre-ACA to 6.1% 2 years post-ACA. At the same time, the national uninsured rate dropped from 14.7% to 9.4%. Medicaid expansion in the neighboring state of Illinois had a slightly smaller impact; its uninsured rate dropped from 12.9% to 7.0%. Conversely, Tennessee, a state that

did not expand Medicaid, experienced a modest decrease in the uninsured rate (from 13.8% to 10.2%). The population most affected by the expansion of Medicaid was those under 138% of national poverty level, which demonstrated a nearly 3-fold drop in the rate of uninsured individuals (from 25.0% to 9.4%).¹⁰

When looking specifically at colorectal cancer (CRC), Kentucky ranks first nationwide for incidence (50.0 cases per 100,000) and fifth for mortality (17.2 deaths per 100,000).^{1,2} As expected, Appalachian Kentucky has an even higher incidence (55.1 cases per 100,000) and mortality (20.2 deaths per 100,000).² Screening for CRC has been demonstrated to significantly decrease incidence and mortality.^{11,12} The US Preventative Services Task Force recommended screening for CRC beginning at the age of 50, with 1 of the following tests: high-sensitivity fecal occult blood testing annually, sigmoidoscopy every 5 years, or colonoscopy every 10 years.¹³ In the past, Kentucky has reported low rates of CRC screening. In 1999, only 34.7% of the Kentucky population received CRC screening of any type, ranking 49th in the nation.¹⁴ These results prompted several state-wide screening initiatives, including the establishment of the Kentucky Colon Cancer Screening Program and the Kentucky Colon Cancer Screening Advisory Committee in 2002. As a result, CRC screening rates improved to 65.9% in those 50 years old or older in 2012. However, CRC screening rates, although improved in western and central Kentucky, remained low in eastern Appalachian Kentucky.^{15,16} The purpose of this study was to evaluate the effect of ACA Medicaid expansion on CRC screening, incidence, and survival in the Kentucky population, with a particular focus on Appalachian Kentucky.

METHODS

Data sources

Kentucky CRC screening, incidence, and outcomes data were obtained from 2 distinct databases. Screening data on CRC were obtained from the Kentucky Hospital Discharge Database, which resided in the Kentucky Cabinet for Health and Family Services (KHFS). Ethical approval for the use of this database was obtained from the University of Kentucky's Office of Research Integrity Institutional Review Board. The sample population included all patients older than 20 years who underwent CRC screening from January 1, 2011 to December 31, 2016. Each screening occurrence was captured through the CPT code involving either screening or diagnostic colonoscopy, sigmoidoscopy, guaiac-based fecal occult test, fecal immunochemical test, or fecal DNA test. Each case was then confirmed with the ICD (9 and 10) code for screening visits, allowing for the capture of recoded endoscopic procedures from screening to diagnostic due to positive findings.

Colorectal cancer demographics, incidence, and cancer outcomes data in the state of Kentucky were obtained through the Institutional Review Board-approved collaboration with the Kentucky Cancer Registry (KCR). A data use agreement was obtained between the investigator and KCR in April 2018. The KCR is a population-based registry and has been awarded the highest level of certification by the North American Association of Central Cancer Registries for an objective evaluation of completeness, accuracy, and timeliness every year since 1997. In addition, KCR is a National Cancer Institute Surveillance, Epidemiology, and End Results population-based cancer registry. The KCR also links its

database annually with the State Death Certificate data and National Death Index to capture the most accurate survival information.¹⁷ The study population included all patients 20 years and older, who were diagnosed with CRC between January 1, 2011 and December 31, 2016. Only the first invasive primary CRC was included in the analysis. Cases captured through autopsy or death certificates were excluded. Measures obtained include demographics (age at diagnosis, sex, race, metropolitan status, Appalachian status) and insurance coverage (Medicaid, Medicare, other public insurance, private insurance, and no insurance) based on payer information at the time of diagnosis from the KCR. Other variables of interest, such as socioeconomic (percentage below poverty status at the county level, high school education ascertainment at the county level) and clinical information (tumor grade, stage at diagnosis, and survival) were also included in the data analysis.

For the purpose of this study, the post-ACA implementation time period was defined as the implementation of Medicaid expansion on January 1, 2014, to December 31, 2016. The pre-ACA period was defined as an equal length of time before ACA implementation from January 1, 2011 to December 31, 2013. County of residence at time of discharge from the KHFS or time of diagnosis from the KCR were used to define patients' geographic regions. Metropolitan status was based on the 2013 Urban-Rural Continuum codes, with the values of 1 to 3 as urban and 4 to 9 as rural.¹⁸ The county-level Appalachian status was defined according to the Appalachia Regional Commission, as the 54 counties in Eastern Kentucky.⁵ The 2008 to 2012 American Community Survey was used to create the poverty status and high school education ascertainment variables, which were collapsed into 4 levels based on the quartiles of their distributions. Poverty status was categorized as low (<16.2%), moderate (16.2% to 18.1%), high (18.2% to 21.7%), and very high (>21.7%); education ascertainment was categorized as very low (<75.8%), low (75.8% to 84.3%), moderate (84.4% to 88.0%), and high (88.1% to 91.8%). Stage at diagnosis was also categorized as early (stages I and II) and late stage (stages III and IV). Survival was defined as length of time from date of diagnosis to death or end of the study period.

Statistical analysis

Descriptive analysis was conducted for all variables. Chi-square tests were performed to examine the association between ACA status and other covariates, stratified by insurance status. Kaplan-Meier plots and log-rank tests were conducted by ACA status for each insurance type separately. Cox regression analysis was performed to determine whether ACA status is associated with survival while controlling for other variables, Goodness of fit and proportional hazard assumption were examined. Analyses were 2-sided with a p value 0.05 used to identify statistical significance. All analyses were performed using SAS Statistical Software version 9.4 (SAS Institute, Inc).

RESULTS

Patient characteristics

A total of 930,176 patients were screened for CRC from 2011 to 2016. The highest proportion of patients screened was in 2015, and the lowest proportion screened was in 2011 (Table 1). As expected, the highest proportion of those screened were in the ages 51 to 65

group. Interestingly, 8.2% of those screened were younger than 40 years old, which may be secondary to the high incidence of familial causes of CRC in Kentucky.¹⁹ More females were screened than males. The majority of patients who received screening were white (92.7%) and a small proportion were black (6.0%), which is slightly lower than the overall percentage of black patients in Kentucky (8.4%), demonstrating a screening disparity.²⁰ When looking at insurance coverage, nearly half of those screened had private insurance (47.8%), while 9.7% of patients had Medicaid and 1.4% were uninsured. About a fourth of the patients who received screening were Appalachian. When looking specifically at the Medicaid subgroup, higher proportions of female (62.6%) and black patients (9.6%) received screening compared with all insurance types. Nearly half of the Medicaid patients who received screening were Appalachian (42.3%).

Impact of Affordable Care Act expansion on colorectal cancer screening

A total of 408,500 patients were screened pre-ACA and 521,676 were screened after ACA implementation, an increase of 27.7% (Table 2). Colonoscopy was used as the major screening method in 72.7% of patients. The 51 to 65 years age group had the highest increase in screening, while both sexes increased proportionally. When comparing screening rates based on insurance coverage, patients with Medicaid demonstrated the highest increase in CRC screening. A total of 69,328 Medicaid patients received screening after ACA implementation compared with 20,980 individuals who were screened pre-ACA, representing an increase of 230%. Screening rates for patients with private insurance increased by 10.2% and Medicare patients increased by 29.9%. Overall, 43.7% more Appalachian patients received CRC screening after ACA implementation compared with pre-ACA.

When looking specifically at Medicaid patients, individuals in the 51 to 65 age group had the highest improvement in screening (+292.5%). There was also a higher proportional increase in screening in males compared with females after ACA implementation. The increase of coverage in all races remained proportional. Similar to the overall Kentucky trend, Medicaid coverage of Appalachian patients increased by 199.0% while uninsured Appalachian patients decreased by 77.7% after ACA implementation (Fig. 1).

Impact of Affordable Care Act expansion on colorectal cancer incidence

From January 1, 2011 to December 31, 2016, 11,441 Kentucky patients were diagnosed with CRC. After ACA Medicaid expansion, there was not a significant increase in incidence (5,665 pre-ACA vs 5,776 after ACA implementation), but there was a change in the distribution (Table 3). The CRC incidence in the 20 to 49 age group increased by 22.8%, while the age 75 to 90 group decreased by 7.5%, indicating a shift toward an increase in incidence in the younger population consistent with national CRC trends.²¹ When separated by insurance, the proportion of Medicaid patients who were diagnosed with CRC increased by 132.4% after Medicaid expansion. In patients who had Medicaid, there were no significant differences in regard to poverty and education level, indicating a similar population before and after ACA implementation. Consequently, there was a 4-fold decrease in incidence in the uninsured group.

When evaluating patients who had Medicaid coverage, there was an increase in Appalachian CRC incidence (87.8%) (Fig. 2). When separating out incidence by stage in this group, the proportion of early stage diagnoses (stage I/II) increased by 9.3% for Appalachians ($p = 0.09$), which was not noted in non-Appalachians (-1.5% , $p = 0.60$). There was no effect on late stage diagnosis.

Impact of Affordable Care Act expansion on colorectal cancer survival

When evaluating the role of ACA expansion in CRC survival, both Medicaid and Appalachian patients benefited while uninsured patients suffered. After ACA implementation, Medicaid patients exhibited improved survival compared with patients before instituting ACA (Fig. 3). Conversely, the remaining uninsured patients who did not receive coverage from ACA implementation had a worse survival compared to pre-ACA implementation. There were no significant differences in survival for private insurance and Medicare with regard to ACA expansion. Notably, the survival differences after ACA implementation were evident in Medicaid patients after the first year and increased each year thereafter (eTable 1). We noted an overall worse survival (hazard ratio [HR] 2.12, 95% CI 1.23 to 3.67, $p = 0.048$) in the black uninsured population compared with the white population, consistent with national trends.²² This effect was not seen in any other insurance groups.

When controlling for age, sex, race, cancer stage, and grade, Cox regression analysis revealed that all Medicaid patients had improved survival after ACA implementation compared with pre-ACA implementation (HR 0.73, 95% CI 0.58 to 2.11; $p = 0.008$). Interestingly, when looking specifically at Appalachian patients with Medicaid coverage, there was significantly improved survival after ACA implementation compared with the period pre-ACA (Fig. 4). However, there was no difference in survival in the Medicaid non-Appalachian population, indicating the improvement in overall Medicaid patient survival after ACA implementation was heavily contributed by the Appalachian population.

DISCUSSION

The ACA Medicaid expansion has had unprecedented success in providing Medicaid coverage for the uninsured population in Kentucky. Earlier studies demonstrated that implementation of the expansion increased screening in prostate cancer,²³ cervical cancer,²⁴⁻²⁶ and breast cancer.^{25,27} In Kentucky, improved coverage was also associated with earlier diagnosis of breast cancer and improved treatment quality.²⁷ We set out to evaluate the impact of ACA expansion on CRC screening. We found the expansion of Medicaid in Kentucky significantly increased CRC screening, particularly in the Appalachian population. Moreover, ACA expansion was associated with increased CRC incidence in the Medicaid population with a shift toward early stage diagnosis in Appalachian patients. Importantly, we demonstrated for the first time that ACA expansion significantly increased CRC survival in both the Medicaid and Kentucky Appalachian populations.

Our study established the substantial impact of insurance coverage in amplifying CRC screening. Over the past 2 decades, Kentucky has implemented several programs to expand CRC screening.¹⁵ The major barriers to CRC screening include lack of insurance coverage

and lack of provider recommendation.^{6-8,28,29} Our study demonstrated that the ACA Medicaid expansion decreased the number of low-income uninsured patients in Kentucky, helping to alleviate barriers to health care access. By 2015, in the second year of expansion, there was 12% increased access to primary care physicians, allowing more than 85% of low-income patients to easily obtain physician visits.³⁰ Improved health care system contact led to increased preventative screening by enabling access to primary care physicians.⁹ The Behavioral Risk Factor Surveillance System reported in 1999 that the CRC screening rate in Kentucky was 34.7% compared with 43.9% nationally. Screening for CRC plateaued just before ACA implementation, at 65.7%. After ACA implementation in 2014, screening in Kentucky further increased to 69.6% compared with 66.6% nationally.^{14,31} However, Appalachian Kentucky screening lagged behind, at 63.0%.² The most recent 2016 data revealed further improvement of screening rates to 70.1% compared with 67.7% nationally.^{14,31} Similarly, we identified a larger than 3-fold increase in CRC screening 3 years after Medicaid expansion.

In Kentucky, additional insurance coverage increased CRC incidence immediately after ACA implementation. The incidence of CRC has steadily decreased over the past 40 years.^{32,33} Microsimulation models suggest the largest contribution comes from screening, while risk factor reduction and treatment improvements are minor contributors.^{33,34} Early detection of precursor lesions would have immediate reduction of CRC incidence within the first 2 years and maximal reduction by 15 years.^{32,34-38} We would expect an immediate increased incidence in newly insured Medicaid patients as existing cancers are identified. In addition, this population may also have a shift toward earlier stage diagnosis.^{39,40} However, as expected, the removal of pre-cancerous lesions would decrease cancer progression, leading to decreased incidence rates.¹¹ Similarly, we identified an increase of incidence in the Medicaid and Appalachian population immediately after ACA implementation. We demonstrated a trend toward higher rates of early stage (I and II) CRC diagnosis in the Appalachian population, which was not seen in the uninsured population. Because this study evaluated the short-term effects of Medicaid expansion, we would not expect a decrease in CRC incidence.

Screening for CRC is very effective in reducing the cancer-specific mortality risk. Zauber and colleagues¹² demonstrated a 53% reduction of 10-year survival in patients who received a screening colonoscopy. In fact, the impact of CRC screening on survival continues for up to 2 decades.⁴¹ Even so, CRC mortality in Kentucky remain behind national standards. In 2011 to 2015, the mortality rate of CRC nationally was 14.5 per 100,000 compared with 17.0 per 100,000 in the state of Kentucky.² Appalachian Kentucky mortality was even higher, with a more profound benefit from screening.^{42,43} In just a short time interval after ACA implementation, we showed that Medicaid patients had a 27% lower risk of death compared with pre-ACA, while those who were uninsured had an overall worse survival. Notably, the Kentucky Appalachian patients also had a significantly improved survival associated with the dramatic expansion of Medicaid coverage as a result of increased CRC screening.

We demonstrated a markedly improved survival in both the Medicaid and Kentucky Appalachian population in just a short time after ACA implementation. In fact, the

significant survival improvement was evident within the first year. Similarly, several studies including a large meta-analysis demonstrated a survival difference at 3 years after receiving CRC screening, with the maximal effect at 15 years.^{44,45} The short-term effects of a CRC screening program implementation on survival was also found in a Kaiser Permanente health system, demonstrating a significant decrease in mortality within 4 years.¹¹ Our survival follow-up time was greater than 6 years for the pre-ACA group and greater than 4 years for the after ACA implementation group. Because CRC incidence can drop within 2 years after improved screening, survival differences can be seen within our follow-up time period, partly due to early detection and treatment.³⁵ Importantly, the improved survival after ACA implementation was not evident in the private, Medicare, and uninsured populations, indicating the specific association of survival after CRC screening with Medicaid patients.

The results of this study could be generalized to other states that have expanded Medicaid coverage. Nonetheless, there are several limitations to this study. The CRC screening data may contain a small number of patients who underwent more than 1 screening procedure, so were counted twice. However, it is extremely unlikely for a second procedure to be coded as a screening procedure, and more likely to be coded as a diagnostic procedure. In addition, before 2016, post-hoc manipulation of CPT codes was legal. As a result, there may be a bias among the colonoscopies that had CPT codes converted from screening to diagnostic as a result of a positive finding during the procedure. This would have underestimated screening colonoscopies before 2016. Next, the significant survival benefit identified in the Medicaid population after ACA implementation may be contributed by other factors that were not included in the analysis. For example, before ACA implementation, only the most impoverished adults (less than half of FPL) were covered by Medicaid. After implementation, the coverage included up to 138% of the FPL. This higher income group was likely more health conscious and had better access to care, which was evident by the decreased survival in the uninsured population, suggesting that only patients with the lowest level of access remain uninsured after ACA implementation. However, these individual socioeconomic and health access factors were not available for the data analysis. Last, cancer survival is also related to reliable quality treatment, which is not accounted for in our survival analysis. However, due to our demonstration of improvement in survival post-ACA, poor quality treatment would unlikely effect our results negatively.

CONCLUSIONS

The incidence and mortality of colorectal cancer in Kentucky are among the highest in the United States. Affordable Care Act Medicaid expansion has positively affected insurance coverage in this population, leading to improved CRC screening and improved short-term survival. Future long-term survival studies are needed, but the short-term benefits of the ACA expansion have bridged a gap in CRC disparities in Kentucky.

Extended Data

eTable 1.

Lifetable by Insurance Status

Insurance, y	Pre-ACA		Post-ACA		p Value
	Surviving	95% CI	Surviving	95% CI	
Private					0.7877
0	1.000	–	1.000	–	
1	0.900	(0.886–0.914)	0.903	(0.888–0.916)	
2	0.820	(0.803–0.839)	0.826	(0.805–0.844)	
3	0.764	(0.744–0.784)	0.764	(0.736–0.789)	
Medicare					0.1980
0	1.000	–	1.000	–	
1	0.753	(0.738–0.768)	0.755	(0.739–0.771)	
2	0.658	(0.641–0.675)	0.631	(0.612–0.650)	
3	0.579	(0.561–0.596)	0.552	(0.528–0.575)	
Medicaid					0.0024
0	1.000	–	1.000	–	
1	0.779	(0.727–0.822)	0.838	(0.807–0.864)	
2	0.641	(0.584–0.693)	0.739	(0.700–0.773)	
3	0.570	(0.511–0.624)	0.662	(0.613–0.707)	
Uninsured					0.0335
0	1.000	–	1.000	–	
1	0.841	(0.795–0.877)	0.695	(0.560–0.796)	
2	0.733	(0.679–0.779)	0.620	(0.475–0.736)	
3	0.647	(0.590–0.697)	0.540	(0.376–0.679)	

ACA, Affordable Care Act.

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Abbreviations and Acronyms

ACA	Affordable Care Act
CRC	colorectal cancer

FPL	federal poverty level
KCR	Kentucky Cancer Registry
KHFS	Kentucky Cabinet for Health and Family Services

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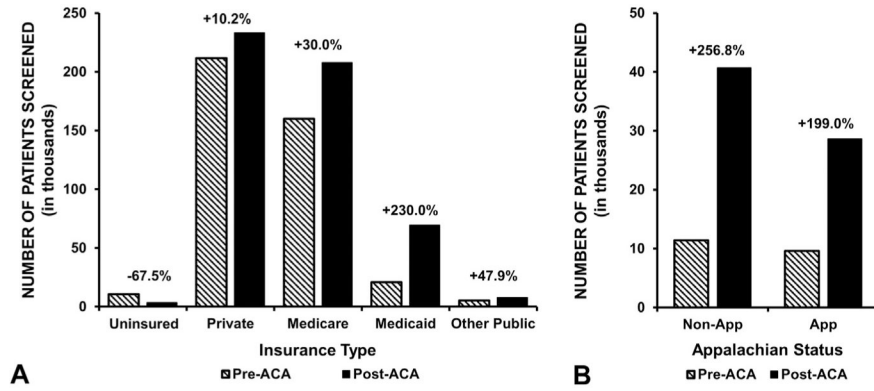


Figure 1. Colorectal cancer (CRC) screening by insurance and Appalachian (App) status. Colorectal cancer screening data were obtained from the Kentucky Cabinet for Health and Family Services from January 1, 2011 to December 31, 2016. (A) All screening cases were separated by insurance status depending on pre-Affordable Care Act (ACA) (screening obtained in 2011 to 2013) or post-ACA status (screening obtained in 2013-2016). (B) Patients with Medicaid coverage who received screening were separated by Appalachian and non-Appalachian status and compared pre- and post-ACA implementation.

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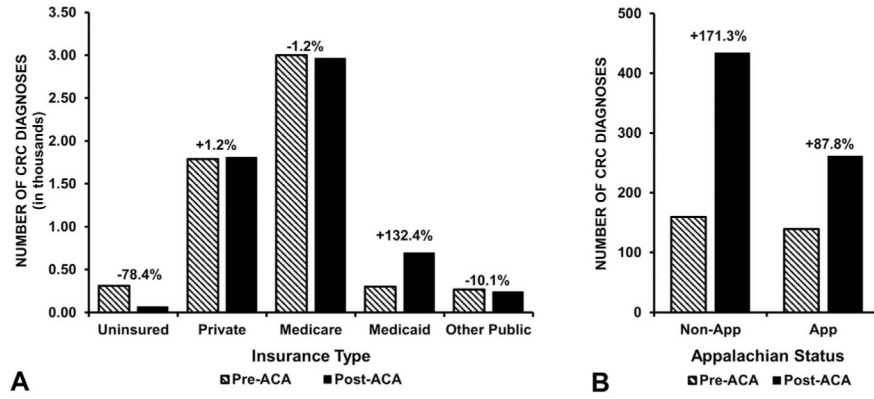


Figure 2. Colorectal cancer (CRC) incidence by insurance and Appalachian (App) status. The CRC incidence from January 1, 2011 to December 31, 2016 was obtained from the Kentucky Cancer Registry. Pre-ACA was defined as the time period from 2011 to 2013 while post-ACA was from 2014 to 2016. (A) All cases of CRC were separated out by insurance types and compared before and after ACA implementation. (B) Incidence rates of CRC were compared in all Medicaid patients separated by Appalachian and non-Appalachian status.

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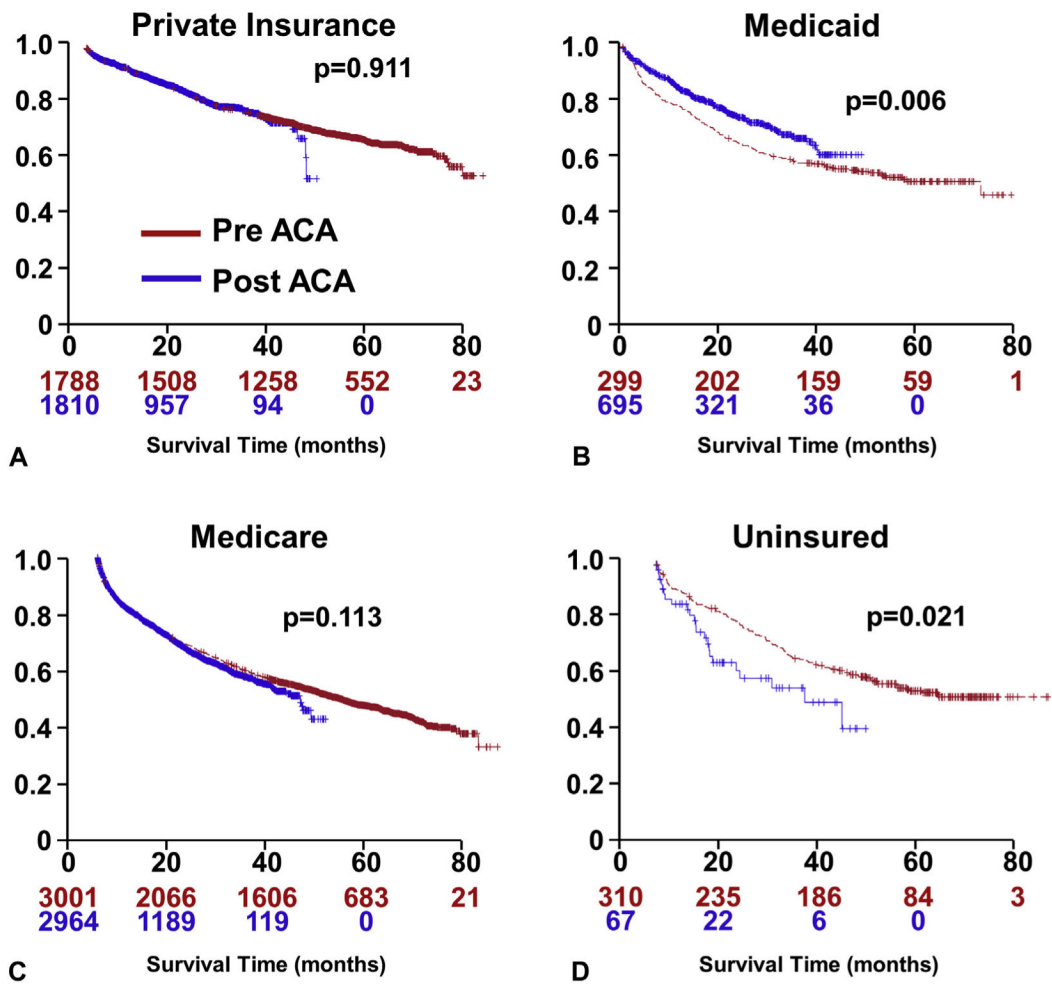


Figure 3. Colorectal cancer (CRC) survival after Affordable Care Act (ACA) by insurance type. Survival analysis was performed via Kaplan-Meier plots. Pre-ACA was defined as the time period between 2011 and 2013, and post-ACA was defined as the time period between 2014 and 2016. All CRC cases were separated by insurance status: (A) private; (B) Medicaid; (C) Medicare; and (D) no insurance.

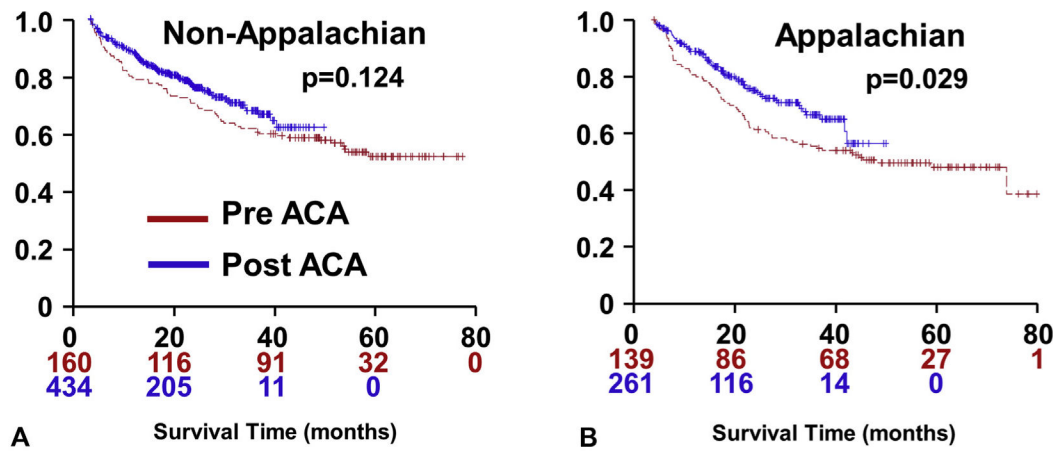


Figure 4.

Colorectal cancer (CRC) survival for Medicaid patients after Affordable Care Act (ACA) by Appalachian status. Medicaid patients who were diagnosed with CRC were identified in the Kentucky Cancer Registry from January 1, 2011 to December 31, 2016. Survival analysis was performed with Kaplan-Meier plots to evaluate survival in the (A) non-Appalachian and (B) Appalachian population.

Table 1.

Patient Demographics

Patient characteristic	n	%
All Kentucky patients, 2011–2016, n = 930,176		
ACA Status		
Pre-ACA *	408,500	43.9
Post-ACA	521,676	56.1
Year screened		
2011	124,049	13.3
2012	142,166	15.3
2013	142,285	15.3
2014	151,956	16.3
2015	194,406	20.9
2016	175,314	18.9
Age		
20–40 y	75,923	8.2
41–50 y	129,050	13.9
51–65 y	422,588	45.4
66–70 y	118,714	12.8
>71 y	183,901	19.8
Sex		
Female	517,830	55.7
Male	412,346	44.3
Race		
White	862,144	92.7
Black	55,742	6.0
Other	12,290	1.3
Insurance		
Not insured	14,064	1.5
Private	444,794	47.8
Medicare	367,974	39.6
Medicaid	90,308	9.7
Other public †	13,036	1.4
Stage		
I	2,444	21.8
II	2,600	23.2
III	2,789	24.9
IV	2,224	19.8
Unknown	1,152	10.3

Patient characteristic	n	%
Appalachian status		
Non-Appalachian	682,545	73.4
Appalachian	247,631	26.6
Medicaid patients only, 2011–2016, n = 90,308		
ACA Status		
Pre-ACA *	20,980	23.2
Post-ACA	69,328	76.8
Year screened		
2011	6,606	7.3
2012	7,282	8.1
2013	7,092	7.8
2014	20,394	22.6
2015	27,772	30.8
2016	21,162	23.4
Age		
20–40 y	19,762	21.9
41–50 y	21,052	23.3
51–65 y	48,151	53.3
66–70 y	664	0.7
>71 y	679	0.8
Sex		
Female	56,510	62.6
Male	33,798	37.4
Race		
White	79,798	88.4
Black	8,661	9.6
Other	1,849	2.0
Appalachian status		
Non-Appalachian	52,112	57.7
Appalachian	38,196	42.3
Stage		
I	195	19.7
II	207	20.9
III	237	24.0
IV	255	25.8
Unknown	95	9.6

* Pre-Affordable Care Act (ACA) from 2011 to 2013; post-ACA from 2014–2016.

† Includes TRICARE, Veterans Affairs, and military insurances.

Table 2. Bivariate Analysis of Pre-Affordable Care Act and Post-Affordable Care Act Colorectal Cancer Screening

Patient characteristic	Colorectal cancer screening, n (%)		p Value
	Pre-ACA* (n = 408,500)	Post-ACA (n = 521,676)	
Age			< 0.0001
20-40 y	36,002 (8.8)	39,921 (7.7)	
41-50 y	59,825 (14.7)	69,225 (13.3)	
51-65 y	182,362 (44.6)	240,226 (46.0)	
66-70 y	50,355 (12.3)	68,359 (13.1)	
>71 y	79,956 (19.6)	103,945 (19.9)	
Sex			< 0.0001
Female	228,830 (56.0)	289,000 (55.4)	
Male	179,670 (44.0)	232,676 (44.6)	
Race			< 0.0001
White	379,190 (93)	482,954 (93)	
Black	23,817 (6)	39,125 (6)	
Other	5,493 (1)	6,797 (1)	
Insurance			< 0.0001
Uninsured	10,617 (2.6)	3,447 (0.7)	
Private	211,618 (51.8)	233,176 (44.7)	
Medicare	160,027 (39.2)	207,947 (39.8)	
Medicaid	20,980 (5.1)	69,328 (13.3)	
Other public [‡]	5,258 (1.3)	7,778 (1.5)	
Appalachian status			< 0.0001
No	306,880 (75.1)	375,665 (72.0)	
Yes	101,620 (24.9)	146,011 (28.0)	

* Pre-Affordable Care Act (ACA) from 2011-2013, post-ACA from 2014-2016.

[‡] Includes TRICARE, Veterans Affairs, and military insurances.

Table 3. Bivariate Analysis of Pre-Affordable Care Act and Post-Affordable Care Act Colorectal Cancer Incidence Separated by All Insurance Types and Medicaid Only

Patient characteristic	Pre-ACA* (n = 5,665), n (%)	Post-ACA (n = 5,776), n (%)	p Value
All insurance types			
Age			< 0.001
20–49 y	648 (11.4)	796 (13.8)	
50–64 y	2,005 (35.4)	2,072 (35.9)	
65–74 y	1,456 (25.7)	1,468 (25.4)	
75 y	1,556 (27.5)	1,440 (24.9)	
Sex			0.915
Female	2,641 (46.6)	2,687 (46.5)	
Male	3,024 (53.4)	3,089 (53.5)	
Race			0.007
White	5,237 (92.4)	5,302 (91.8)	
Black	365 (6.5)	368 (6.4)	
Other	63 (1.1)	106 (1.8)	
Insurance			< 0.001
Uninsured	310 (5.5)	67 (1.2)	
Private	1,788 (31.5)	1,810 (31.3)	
Medicare	3,001 (53.0)	2,964 (51.3)	
Medicaid	299 (5.3)	695 (12.0)	
Other public [†]	267 (5.7)	240 (4.2)	
Appalachian status			0.131
No	3,888 (68.6)	3,888 (67.3)	
Yes	1,777 (31.4)	1,888 (32.7)	
Tumor grade			< 0.001
Well differentiated	265 (4.7)	437 (7.6)	
Moderately differentiated	3,731 (65.9)	3,735 (64.6)	

Patient characteristic	Pre-ACA* (n = 5,665), n (%)	Post-ACA (n = 5,776), n (%)	p Value
Poorly differentiated	424 (7.5)	439 (7.6)	
Undifferentiated	466 (8.2)	425 (7.4)	
Unknown	779 (13.7)	740 (12.8)	
Medicaid only			
Age, y			0.003
20–49	78 (26.1)	220 (31.7)	
50–64	183 (61.1)	433 (62.3)	
65–74	19 (6.4)	23 (3.3)	
75–90	19 (6.4)	19 (2.7)	
Sex			0.059
Female	152 (50.8)	308 (44.3)	
Male	147 (49.2)	387 (55.7)	
Race			0.633
White	268 (89.6)	603 (86.8)	
Black	28 (9.4)	83 (11.9)	
Other	3 (1.0)	9 (1.3)	
Appalachian status			0.008
No	160 (53.5)	434 (62.5)	
Yes	139 (46.5)	261 (37.5)	
Poverty level [‡]			0.072
Low	51 (17.1)	148 (21.3)	
Moderate	62 (20.7)	166 (23.9)	
High	72 (24.1)	172 (24.7)	
Very high	114 (38.1)	209 (30.1)	
High school education [§]			0.084
Very low	121 (40.5)	217 (31.2)	
Low	69 (23.1)	167 (24.0)	
Moderate	85 (28.4)	237 (34.1)	

Patient characteristic	Pre-ACA* (n = 5,665), n (%)	Post-ACA (n = 5,776), n (%)	p Value
High	24 (8.0)	74 (10.7)	

* Pre-Affordable Care Act (ACA) from 2011–2013, post-ACA from 2014–2016.

† Includes TRICARE, Veterans Affairs, and military insurances.

‡ Low: under poverty level 16.2%; Moderate: under poverty level 16.3%–18.1%; High: under poverty level 18.2%–21.7%; Very High: under poverty level 21.8%.

§ Very Low: completed high school 75.8%; Low: completed high school 75.9%–84.4%; Moderate: completed high school 84.5%–88.1%; High: completed high school 88.2%.