Socioeconomic Determinants of Healthcare Quality and Outcomes in U.S. States

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Abstract: As healthcare becomes a more fundamental and increasingly discussed political issue, healthcare quality lies at the foundation of creating an ideal healthcare system. What socioeconomic factors influence the quality of healthcare and efficacy of treatments in U.S. states? This paper uses a linear regression in an attempt to uncover determinants of a lower colorectal cancer mortality rate and improved healthcare outcomes in U.S. states from 2004 and 2014. Our regression results indicate that, contrary to this paper's hypothesis, the uninsured rate and real GDP per capita were not statistically significant indicators of colorectal cancer mortality and healthcare outcomes. Despite this, the results support the hypothesis that both higher educational attainment and a higher urban share of counties would be associated with a lower colorectal cancer mortality rate, ultimately concurring with the findings of the studies by Ross et al. (1995) and Aboagye et al. (2014) cited within this paper. Overall, in addition to educational attainment and urbanization, the linear regressions indicate that the colorectal cancer mortality rate is heavily influenced by initial conditions and factors that affect the incidence rate such as diet, racial breakdown, and medical advancements of the time period.

I. Introduction

In the U.S., one of the most polarizing, yet fundamental, political topics is Healthcare, with nearly 20% of respondents in an August 2017 Gallup poll[1] naming Healthcare the most important problem facing the country. Whether the discussion is over access to care, quality, cost, or any other factor, many Americans are concerned about the healthcare they receive and the factors that influence it, and for good reason. For decades, one of the hallmarks of a developed nation has been an effective healthcare system that tackles existing medical challenges and allows its residents to enjoy a quality of life that was not previously attainable. For example, in 1975, the U.S. 5-year survival rate for colorectal cancer, the second-deadliest form of cancer in the U.S., was 48.6%. Just over 30 years later, in 2009, the 5-year survival rate of colorectal cancer had increased to 66.4%[2]. Improvements in screening technology, preventative care, and overall treatment have propelled this success in the U.S., however, all U.S. state healthcare systems are not equal, and they do not report identical results in their treatment of the disease. This leaves us with a suitable indicator of healthcare quality and efficacy of treatments that we can use to compare and contrast all 50 U.S. states: Colorectal Cancer Mortality Rate.

This study will further analyze perceived determinants of healthcare quality within U.S. states, examining the correlation between colorectal cancer mortality rate and socioeconomic factors such as real GDP per capita, educational attainment, urban share of counties, racial breakdown, and changes in the uninsured rate.

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[1] Gallup, Inc., August 2017

[2] National Cancer Institute, SEER Program, Cancer Statistics.

II. Sample

The sample for this study includes all 50 U.S. states for the years 2004 and 2014, however, it excludes Washington, D.C. based on its small size, lack of a state government, and the exclusive jurisdiction granted to Congress by the U.S. Constitution over the District in "all cases whatsoever" [3]. Despite the exclusion of D.C. based on its political structure, the 50 U.S. states were determined to be suitable for this sample. Due to federalism and the U.S. system of government, U.S. state healthcare systems are similar, but not equal, and make differing decisions on numerous healthcare factors, allowing us to compare and contrast the effects of those decisions. In addition, U.S. states are relatively equal in available infrastructure to treat the disease, as all have at least one cancer hospital or treatment center, with 24 states having a cancer hospital currently ranked in the top 50 by U.S. News & World Report in 2017, and 40 states having one in the top 150[4]. This provides us with 100 observations and allows us to use the colorectal cancer mortality rate in U.S. states as an indicator for healthcare quality and efficacy of treatment.

III. Dependent Variable

Colorectal Cancer Mortality Rate (COLO_MORTALITY)

As stated previously, the dependent variable being used for this study is the Colorectal Cancer Mortality Rate per 100,000 population in 2014, the most recent year of data available from the Department of Health and Human Services, and 2004, a decade earlier. I recognize that there may be some objections to using this variable as an indicator of healthcare quality in each

[3] U.S. Const. art. I, § 8.

[4] U.S. News and World Report, 2017 Best Hospitals for Cancer.

U.S. state, however, it is also used by the U.S. Department of Health and Human Services as a measure of effective treatment[5]. In addition, there are links between improvements in the colorectal cancer mortality rate and effective preventative care that are impossible to ignore. These links are supported in a study by Zauber [2015] on the impact of screening on colorectal cancer mortality, which states that observational studies of screening colonoscopies suggest a reduction in mortality of over fifty percent[6]. The expectation is that states with better healthcare quality will also have superior preventative care and screening infrastructure, and therefore, a lower colorectal cancer mortality rate, all else being equal.

IV. Independent Variables

Uninsured Rate (%UNINSURED)

In this study, to examine and correct for the effect of the level of health insurance coverage in each state, the uninsured rate will be used as an independent variable. To measure the uninsured rate, this paper uses data from the U.S. Census Bureau to determine the percentage of the population with no health insurance coverage throughout the entire year for each state in the years 2004 and 2014. The hypothesis is that states with lower uninsured rates will also have lower colorectal cancer mortality rates due to an expected increase in screenings and access to treatments that stems from a greater percentage of the population being insured. This variable will undoubtedly capture decreases in the uninsured rate that are, at least in part, due to Affordable Care Act provisions. Unfortunately, because of the relatively recent implementation

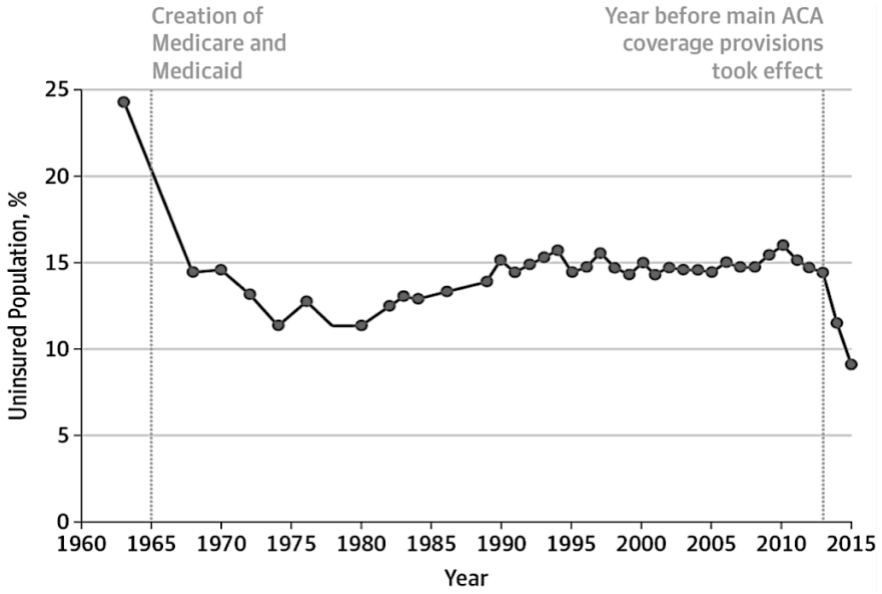
[5] Department of Health and Human Services, Agency for Healthcare Research and Quality.

[6] Zauber, A. G. (2015). The Impact of Screening on Colorectal Cancer Mortality and Incidence – Has It Really Made a Difference? *Digestive Diseases and Sciences*, 60(3), 681–691.

of the ACA, this study will not incorporate enough data from after the enactment of the healthcare law to comment on its effects on healthcare quality and outcomes. From 2010 to 2014, numerous states enacted laws that limited local ACA implementation, opted-out of reforms such as the individual and employer mandates, or chose not to expand Medicaid under the new health law. Due to this, gains made from the ACA also vary temporally and quantitatively at the state level, and this only emphasizes the need for more data and observations from years after the laws implementation to make accurate conclusions about its effects.

In Figure 4.1 below, which was drawn from a journal article authored by former President Barack Obama[7], we can see evidence that the implementation of the Affordable Care Act was a significant catalyst for lower uninsured rates in the United States. Therefore, although this paper will not be able to make connections between the Affordable Care Act and healthcare quality, any future discussion on changes to the U.S. uninsured rate during this time period should note the relevance of the ACA to those changes:

Figure 4.1



[7] Obama, B. (2016). United States Health Care Reform Progress to Date and Next Steps. *JAMA*, 316(5), 525–532.

Real GDP per Capita (REAL_GDP)

This study includes Real GDP per Capita of each state in chained 2009 dollars as an independent variable to reflect the impact of income on healthcare quality. Intuitively, the expectation beforehand is that higher GDP per capita will lead to improved healthcare quality and outcomes, as families and individuals have more money to spend on healthcare.

African-American % of Population (%AFR_AMERICAN)

Numerous studies have shown evidence of higher colorectal cancer mortality rates for African-Americans, which can be attributed to a few different factors. Most notably, regression analysis in a study by Dimou, Syrigos, and Saif [2009] confirmed that there is an "African-American predominance in right-sited tumors", which are measurably deadlier than left-sided colon tumors[8]. To control for the effect this might have on a state's overall colorectal cancer mortality rate, this study will include the percentage of the population that is African-American as an independent variable.

Colorectal Cancer Incidence Rate (COLO_INCIDENCE)

In order to account for discrepancies in factors that are linked to the incidence of colorectal cancer mortality such as sex and diet, this study will use the colorectal cancer incidence rate for each state in 2004 and 2014 as an independent variable. We would also expect the age of a state's population to have a significant impact on the colorectal cancer mortality rate of that state, as the average age of diagnosis for colon cancer is 68 for men and 72 for women. In

[8] Dimou, A., Syrigos, K. N., & Saif, M. W. (2009). Disparities in colorectal cancer in African-Americans vs Whites: Before and after diagnosis. *World Journal of Gastroenterology: WJG*, 15(30), 3734–3743.

addition, screenings for colorectal cancer are not recommended until age 50 and older[9]. We include this variable because we are specifically interested in the efficacy of treatment in each state, and by correcting for the incidence of colorectal cancer we are able to analyze the ability of each state to limit colorectal cancer mortality rate regardless of the incidence rate. For example, we would expect a state with a higher colorectal cancer incidence rate to also have a higher colorectal cancer mortality rate than other states, all else being equal.

Educational Attainment (%BACHELOR)

There is well-established evidence that the level of educational attainment in a region or state can impact healthcare outcomes. For instance, a 1995 study on links between education and health published in the American Sociological Review[10] stated that, "Well educated people experience better health than the poorly educated, as indicated by high levels of self-reported health and physical functioning and low levels of morbidity, mortality, and disability." This paper will include a variable measuring the population of a state that is 25 and older who have earned at least a bachelor's degree to account for educational attainment in a state. Based on prior research, the hypothesis is that higher levels of educational attainment in a state will be correlated with a lower colorectal cancer mortality rate.

Year (YEAR)

As we are using data from both 2004 and 2014, a dummy variable representing the year will be used to control for nationwide medical advancements and healthcare improvements over

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[9] American Cancer Society, Colorectal Cancer Facts & Figures 2017-2019.

[10] Ross, C.E., & Wu, C. (1995). The Links Between Education and Health. *American Sociological Review,* 60(5), 719-745.

the decade between 2004 and 2014. A value of 1 will be assigned to data from 2014, while a value of 0 will be assigned to data from 2004.

Urban Share of Counties (%URBAN_COUNTY)

A 2014 study on rural-urban differences in access to specialist providers of colorectal cancer care in the United States[11] found that there is statistically significant evidence that a "rural-urban disparity exists in the density of gastroenterologists, general surgeons, and radiation oncologists who traditionally provide colorectal cancer screening services and treatment." Moreover, the study indicated that this could "affect access to these services and may negatively influence outcomes for colorectal cancer in rural areas." Due to this, we will include a variable measuring the share of counties in a state that are deemed urban. This study will use the 2003 and 2013 Rural-Urban Continuum Codes to determine whether a county is rural or urban[12]. For this paper, similar to the study referenced above, codes between 1 and 5 were determined to be urban, while codes 6 through 9 were categorized as rural. Based on the prevailing research, we hypothesize that an increase in the urban share of counties in a state will be associated with a decrease in the colorectal cancer mortality rate.

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[11] Aboagye, J.K., Kaiser, H.E., & Hayanga, A.J. (2014). Rural-Urban Differences in Access to Specialist Providers of Colorectal Cancer Care in the United States: A Physician Workforce Issue. *JAMA Surgery*, 149(6), 537-543.

[12] U.S. Department of Agriculture, Economic Research Service, Rural-Urban Continuum Codes

V. Summary Statistics and Correlation Matrix

The summary statistics for each variable are provided in Table 5.1 below:

Table 5.1

	Mean	St. Dev.	Minimum	Maximum	Count
COLO_MORTALITY	16.371	2.639	10.9	22.4	100
%UNINSURED	11.999	3.604	3.3	23.6	100
REAL_GDP	46563.3	8617.3	30509	70986	100
%AFR_AMERICAN	11.201	9.545	0.5	37.8	100
COLO_INCIDENCE	49.061	8.588	25.0	72.5	100
%BACHELOR	28.019	4.984	15.3	41.2	100
YEAR	0.5	0.503	0	1	100
%URBAN_COUNTY	51.823	24.175	9.4	100	100

In addition, due to concerns about collinearity between the independent variables in this study, a correlation matrix is provided in Table 5.2 below to show the correlation between each of the independent variables. By analyzing the table, it can be seen that no two independent variables shared a correlation coefficient with a magnitude greater than ***0.584****:*

Table 5.2

	%UNINSURED	REAL_GDP	%AFR_AMERICAN	COLO_INCIDENCE	%BACHELOR	YEAR	%URBAN_COUNTY
%UNINSURED	1.00						
REAL_GDP	-0.299	1.00					
%AFR_AMERICAN	0.197	-0.077	1.00				
COLO_INCIDENCE	-0.134	-0.232	0.060	1.00			
%BACHELOR	-0.448	**0.584**	-0.094	-0.385	1.00		
YEAR	-0.338	0.138	0.053	-0.472	0.245	1.00	
%URBAN_COUNTY	-0.222	0.338	0.326	0.054	0.420	0.045	1.00

VI. Regression Results

Model:

$$\mathbf{Y} = \beta_0 + \beta_1\mathbf{X_1} + \beta_2\mathbf{X_2} + \beta_3\mathbf{X_3} + \beta_4\mathbf{X_4} + \beta_5\mathbf{X_5} + \beta_6\mathbf{X_6} + \beta_7\mathbf{Z_7} + \boldsymbol{\varepsilon}$$

X_1 = % Uninsured

X_2 = Real GDP per Capita

X_3 = % African-American

X_4 = Colorectal Cancer Incidence Rate

X_5 = Population 25 and Older with Bachelor's Degree

X_6 = Urban Share of Counties

Z_7 = Year (Dummy Variable)

ε = Error Term

COLO_MORTALITY $= \beta_0 + \beta_1$***%UNINSURED*** $+ \beta_2$***REAL_GDP*** $+ \beta_3$***%AFR_AMERICAN*** $+$ β_4***COLO_INCIDENCE*** $+ \beta_5$***%BACHELOR*** $+ \beta_6$***%URBAN_COUNTY*** $+ \beta_7$***YEAR*** $+$ ***ERROR***

In addition to the model described above, ***this study will also run a second regression*** *that does not include the Colorectal Cancer Incidence Rate in order to observe the impact this has on the regression statistics, results, and interpretation.*

Regression Statistics:

Table 6.1

	REGRESSION (1)	REGRESSION (2)
R-SQUARED	**0.762**	0.678
ADJUSTED R-SQUARED	0.744	0.657
OBSERVATIONS	100	100

Regression Results:

Table 6.2: Regression 1

	COEFFICIENT	ST. ERROR	P-VALUE
%UNINSURED	8.0598	5.414	*0.140*
REAL_GDP	0.0000299	0.0000195	*0.128*
%AFR_AMERICAN	**7.9529**	1.621	***0.00000398***
COLO_INCIDENCE	**0.1335**	0.023	***0.000000146***
%BACHELOR	**-9.0114**	4.299	***0.0388***
YEAR	**-2.1623**	0.361	***0.0000000394***
%URBAN_COUNTY	**-1.6504**	0.704	***0.0212***
INTERCEPT	11.0307	2.527	*0.0000331*

Table 6.3: Regression 2

	COEFFICIENT	ST. ERROR	P-VALUE
%UNINSURED	-9.342	5.171	*0.074*
REAL_GDP	0.0000209	0.0000225	*0.355*
%AFR_AMERICAN	**8.975**	1.863	***0.00000566***
%BACHELOR	**-21.081**	4.328	***0.00000454***
YEAR	**-3.374**	0.337	***1.941×10^{-16}***
%URBAN_COUNTY	-0.834	0.797	*0.298*
INTERCEPT	23.541	1.445	*5.518×10^{-29}*

Uninsured Rate (%UNINSURED)

The regression results for this variable were not statistically significant at the 95% confidence level for either regression, so this paper's original hypothesis is not supported. The **p-values for the first and second regressions** were **0.140** and **0.074**, respectfully. In considering any results from this variable, it should be noted that this paper does not distinguish between the type of healthcare insurance, and therefore, this paper would not be able to make any reasonable conclusions on specific policies such as Medicaid expansion. Moreover, due to the recent implementation of Affordable Care Act provisions, additional years of data will be necessary to properly observe the effect of the legislation on the uninsured rate, the colorectal cancer mortality rate, and healthcare quality overall.

Real GDP per Capita (REAL_GDP)

With a **p-value of 0.128**, the result for Real GDP per Capita is not statistically significant at the 95% confidence level in our main regression. Similarly, the variable also did not produce a statistically significant result in the second regression, with a **p-value of 0.355**.

African-American % of Population (%AFR_AMERICAN)

As we hypothesized from prior research into colorectal cancer mortality and race, the main regression results for this variable were statistically significant at the 99% confidence level, with the coefficient indicating a relatively small increase in the colorectal cancer mortality rate of **.079 per 100,000** for each percentage point increase in the percentage of the population that is African-American. Additionally, in our second regression, the results were statistically significant and indicated a slightly larger increase in the colorectal cancer mortality rate for each percentage point increase in the variable, further supporting our hypothesis. Finally, this result also supports the findings of Dimou, Syrigos, and Saif (2009) which were referenced earlier.

Colorectal Cancer Incidence Rate (COLO_INCIDENCE)

While we did not include this in our second regression, the main regression results for the variable, which accounted for discrepancies in factors affecting the colorectal cancer incidence rate such as sex, age, and diet in each state, were significant at the 99% confidence level with a **p-value of 0.00000015**. The results support the hypothesis made earlier that a higher colorectal cancer incidence rate would lead to a higher colorectal cancer mortality rate as well, with the coefficient of 0.138 implying an increase in the colorectal cancer mortality rate of **0.134 per 100,000** for each increase in the colorectal cancer incidence rate of 1 per 100,000.

Educational Attainment (%BACHELOR)

The results for our variable measuring educational attainment were statistically significant in both regressions and support the original hypothesis. Intuitively, this is what would be expected, as the links between higher education and improved healthcare are well-established, however, it is interesting that this connection was still seen in our study of the U.S., where educational attainment is already higher than others, even among OECD countries. It's possible that among states or countries with much lower educational attainment the coefficient for this

variable would be much higher, as it is reasonable to expect educational attainment to have a decreasing marginal benefit on healthcare.

Year (YEAR)

As we expected due to technological change, the main regression results for our dummy variable controlling for the year support our original hypothesis and allow us to reject the null hypothesis with statistical significance at the 99% confidence level due to a **p-value of 0.00000004**. The coefficient, calculated to be negative at -2.16, implies a decrease in the colorectal cancer mortality rate of **2.16 per 100,000** over the ten-year period from 2004 to 2014, most likely due to technological and medical advancements. In the second regression, the variable was statistically significant at an even lower p-value, adding additional support for the validity of our findings.

Urban Share of Counties (%URBAN_COUNTY)

In our main regression, the results for the variable measuring the urban share of counties support the original hypothesis that a higher urban share of counties will lead to a lower colorectal cancer mortality rate. In the second regression, however, the variable was not statistically significant at any generally accepted level. The coefficient from our main regression also indicates a very limited impact on the colorectal cancer mortality rate of just **-.0165** per 100,000 for a percentage point increase in the urban share of counties.

VII. Conclusion

The regression results, particularly with our first model, indicate that colorectal cancer mortality, at least in U.S. states, is heavily dependent on initial conditions such as racial

breakdown and factors that affect colorectal cancer incidence. In addition, this study finds that educational attainment, technological advancement over time, and urbanization are all statistically significant in indicating the colorectal cancer mortality rate of a state. Contrary to our expectations, which were based on intuition and a study by Zauber (2015)[13], the uninsured rate was not associated with a change in the colorectal cancer mortality rate at a statistically significant level. This is possibly due to the relatively recent implementation of the Affordable Care Act and its associated provisions, which will most likely take several years to see the full impact on healthcare quality and outcomes. Therefore, it is the recommendation of this paper that further research is done when additional years of data are available.

[13] Zauber, A. G. (2015). The Impact of Screening on Colorectal Cancer Mortality and Incidence – Has It Really Made a Difference? *Digestive Diseases and Sciences*, 60(3), 681–691.

Works Cited

Aboagye, J.K., Kaiser, H.E., & Hayanga, A.J. (2014). Rural-Urban Differences in Access to Specialist Providers of Colorectal Cancer Care in the United States: A Physician Workforce Issue. *JAMA Surgery*, 149(6), 537-543.

American Cancer Society. (2017). *Colorectum at a Glance*. Retrieved from https://cancerstatisticscenter.cancer.org/#!/cancer-site/Colorectum

Dimou, A., Syrigos, K. N., & Saif, M. W. (2009). Disparities in colorectal cancer in African-Americans vs Whites: Before and after diagnosis. *World Journal of Gastroenterology: WJG*, 15(30), 3734–3743.

Gallup, Inc. (2017). *Most Important Problems Facing the U.S.* Retrieved from http://news.gallup.com/poll/219020/government-top-problem-race-immigration.aspx?g_source=CATEGORY_HEALTHCARE&g_medium=topic&g_campaign=tiles

National Cancer Institute. (2014). *Cancer Stat Facts: Colorectal Cancer*. Retrieved from https://seer.cancer.gov/statfacts/html/colorect.html

Obama, B. (2016). United States Health Care Reform Progress to Date and Next Steps. *JAMA*, 316(5), 525–532.

U.S. Const. art. I, § 8.

U.S. News & World Report. (2017). *Best Hospitals for Cancer.* Retrieved from https://health.usnews.com/best-hospitals/rankings/cancer

United States Bureau of Economic Analysis. (2004, 2014). *Per capita real GDP by state (chained 2009 dollars)*. Retrieved from https://www.bea.gov/iTable/index_regional.cfm

United States Census Bureau. (2004, 2014). *ACS Educational Attainment by Degree-Level and Age-Group.* Retrieved from

http://www.higheredinfo.org/dbrowser/?year=2014&level=nation&mode=data&state=0&submeasure=232

United States Census Bureau. (2004, 2014). *Current Population Survey*. Retrieved from https://www.census.gov/cps/data/cpstablecreator.html

United States Department of Agriculture. (2003, 2013). *Rural-Urban Continuum Codes*. Retrieved from https://www.ers.usda.gov/data-products/rural-urban-continuum-codes/

United States Department of Health and Human Services. (2004, 2014). *National Healthcare Quality and Disparities Reports.* Retrieved from https://nhqrnet.ahrq.gov/inhqrdr/data/submit

United States Department of Health and Human Services. (2014). *United States Cancer Statistics: 1999-2014 Incidence and Mortality Web-based Report.* Retrieved from https://www.cdc.gov/cancer/colorectal/statistics/index.htm

Zauber, A. G. (2015). The Impact of Screening on Colorectal Cancer Mortality and Incidence – Has It Really Made a Difference? *Digestive Diseases and Sciences*, 60(3), 681–691.