Examining change over time in the association between healthcare access and disparities in colorectal cancer mortality for minorities as compared to whites.

By

Josephine Osaghae

November 30th, 2017
ABSTRACT

Examining change over time in the association between healthcare access on disparities in colorectal cancer mortality for minorities as compared to whites.

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INTRODUCTION: Several studies have looked at the various factors that could explain the disparity in cancer diagnosis outcome including that for colorectal cancer between minorities and Whites. Studies have also shown that when it comes to insurance status Blacks and Hispanics are more likely to have higher uninsured rates. With the implementation of the Affordable Care Act (ACA) in 2010 there has been a decline in the uninsured rate, with the rate of decline differing by state.

AIM: This thesis examines whether the observed decline in CRC mortality rates observed nationally was comparable for minorities and whites in the 25 states with data for both groups. The questions that will guide the thesis:

1) What association can be found between the expanded health care coverage for colorectal cancer screening following the ACA (2010) and colorectal cancer mortality? Does the disparity pattern in CRC mortality for minorities as compared to whites change after 2010?

METHODS: This thesis uses state-level secondary data on colorectal cancer mortality from the period of 1990 to 2013 for 25 states in the United States which had data for White, Black and Hispanic populations. Data were provided each year by the National Vital Statistics System at the National Center for Health Statistics of the Centers for Disease Control and Prevention and the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) Program. Access to care as measured by the uninsured rate for the 25 states derives from various sources and was not
available for each year. Two time periods were identified (early and later period) and mean mortality and insurance rates were calculated over these two intervals. Regression analysis was performed on the two-time intervals of data stacked over two periods (early and later periods), with a binary time indicator variable to differentiate the early and late periods. The regression included the CRC mortality rate for whites and the CRC mortality rates for Blacks and Hispanics for each state in each period (4 observations per state) as the dependent variable, a total of 100 observations. Regressors included the uninsured rate for all populations in each time interval for each state (2 unique observations per state), an indicator of minority versus white race/ethnicity (50 observations=1, rest=0), and a time indicator (later time=1, earlier=0). The time and minority indicators were interacted to test whether minority CRC mortality rates fell after 2010 as compared to Whites, holding constant access to care (insurance status), the overall trend in CRC mortality, and the overall minority effect associated with CRC. Defining the time intervals as periods pre- and post- 2010, the main hypothesis was to assess whether these CRC mortality outcomes changed significantly pre-post the 2010 implementation of the ACA, and whether there were differential effects over time for minorities versus whites.

RESULTS: Over both periods together, a higher state uninsured rate was associated with a higher state CRC mortality rate, but this was not statistically significant (p = 0.294). Over both periods together, the CRC mortality rate for Hispanics and Blacks was higher than that for whites, by 7.94 deaths per 100,000, and this was statistically significant. There was a reduction in the average CRC mortality rate by 4.73 deaths per 100,000 over the time periods for everybody, and this was statistically significant (p = 0.000). However, in the later period, the Black and Hispanic CRC mortality rate fell by an additional 2.073 deaths per 100,000 as compared to the overall decline and this was significant (p = 0.035). Thus, there was a larger decline in the CRC mortality rate for Blacks and Hispanics compared to whites over the two periods, which suggests that the passage of the ACA may have reduced disparities in CRC mortality among minorities as compared to whites.

DISCUSSION: Over the twenty-four-year period from 1990 to 2013, there was a steady decline in the CRC mortality rate for Blacks, Hispanics, and Whites. This thesis shows that the decline in mortality rate is weakly associated with a decline in uninsured rate, when comparing the average rates for both in 2009 and 2013, and not adjusting statistically for other factors. However, the
association between the uninsured rate and CRC mortality rate by race/ethnicity group remains unknown, because data on uninsured by each group was not available for all 25 states in the two-time periods pre- and post- 2010. Also, not known is whether there was a change over time in the association between a state’s uninsured rates and the CRC mortality rates, which we could have ascertained using another time interaction with uninsured rates had these been available by group. Holding overall uninsured rate constant statistically in the model was necessary to disentangle the reduction in the minority CRC mortality rate as compared to Whites by the later period. Failure to hold uninsured rates constant statistically could have resulted in omitted variables bias on the minority effects, assuming that minority uninsured rates differed from whites. Future analyses should attempt to determine what if any insurance effects were present for the different groups. A three-way interaction between uninsured by group and time could also determine whether the insurance effects were stronger for one group than for another, which would have interesting policy implications.
Examining change over time in the association between healthcare access on disparities in colorectal cancer mortality for minorities as compared to whites.

BY

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Date: November 30th, 2017
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In presenting this thesis as a partial fulfillment of the requirements for an advanced degree from Georgia State University, I agree that the Library of the University shall make it available for inspection and circulation in accordance with its regulations governing materials of this type. I agree that permission to quote from, to copy from, or to publish this thesis may be granted by the author or, in his/her absence, by the professor under whose direction it was written, or in his/her absence, by the Associate Dean, School of Public Health. Such quoting, copying, or publishing must be solely for scholarly purposes and will not involve potential financial gain. It is understood that any copying from or publication of this dissertation which involves potential financial gain will not be allowed without written permission of the author.

Josephine O. Osaghae

Signature of Author
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INTRODUCTION

Colorectal cancer (CRC) affects both men and women of all racial and ethnic groups and is the second- leading cause of death by cancer in the United States. According to the Center for disease control (CDC), cancer is a disease condition in which the cells of the body grow out of control, and when this occurs in the colon or rectum it is referred to as colorectal cancer. In some instances, it begins as an abnormal growth called polyps within the inner lining of the colon or rectum, and if left over time these polyps could become cancerous. According to the American Cancer Society, Adenocarcinomas make up 95% of colorectal cancers, however few polyps are adenocarcinomas. Colorectal cancer is also one of the few cancers that there is screening available to find any abnormal growths in the colon and rectum, which can be removed before they become cancerous. Screening can also be used to find colorectal cancer at an early stage, at which time treatment often leads to a cure, thus reducing the incidence and mortality from the condition. Based on this it is recommended (by several organizations, the American Cancer Society, the United States Preventative Task Force, and the CDC) that all adults 50 and over with an average risk be screened regardless of gender, race or ethnicity.

According to the CDC One's risk of getting colorectal cancer increases with age with 90% of cases occurring in those 50 years or older. It could also be found in younger people, especially those with a family history and risk factors which include Inflammatory bowel disease (Crohn’s disease or ulcerative colitis). Lifestyle factors such as lack of physical activity, being overweight or obese, a diet low in fruits and vegetables, or low-fiber and high-fat, alcohol consumption and tobacco use can increase risk. (These are factors often associated more with those of lower SES).
Based on the data from the Cancer Statistics Working Group in 2013, 136,119 people in the United States were diagnosed with colorectal cancer, of which 71,099 were men and 65,020 women.\textsuperscript{33} Based on statistics from the CDC in 2017, the deaths from colorectal cancer were 51,813 of which 27,230 were men and 24,583 women. About nine in ten people whose colorectal cancers are found early and treated appropriately five years later are still alive. In 2014, 65.7% of U.S. adults were up-to-date with colorectal cancer screening; 7% had been screened but were not up-to-date, and 27.3% had never been screened.

One of the factors that increases the likelihood of utilizing screening is affordability and access to care, and access is achieved through availability of health insurance or through Medicaid.\textsuperscript{26} Without screening most colorectal cancers are diagnosed in the late stages resulting in higher mortality or lower survival rates.\textsuperscript{15,26} Despite the existence of an effective screening method there is still a disparity (relative to Whites) in those receiving such screening among certain subpopulations, such as Hispanics, American Indians, Alaskan Natives and those with a lower level of education and income level.\textsuperscript{27,5}

The incidence rates for colorectal cancer are greater for blacks compared to whites and lower for Hispanics as compared to both Whites and Blacks.\textsuperscript{2,20,21} Similarly, the mortality rate for both Blacks and Hispanics is higher than that of Whites.\textsuperscript{20,2} Based on information from the American Cancer Society, the incidence of CRC amongst African-American males is 63.8 per 100,000, compared to 50.9 per 100,000 in White males.\textsuperscript{34} In older data (pre-2010), the mortality rates were also higher for African-American males at 29.4 per 100,000 compared to that of Whites being 19.2 per 100,000. A similar finding was also found for African-American females as compared to Whites, with the former having higher incidence and mortality rates.\textsuperscript{28} There have been several
innovative screening tools developed to diagnose and treat Colorectal cancer over the last three decades, which has resulted in early detection and longer survival times for those with these cancers, thus resulting in a declining mortality rate. However, irrespective of these innovations, if an individual has inadequate or no access to healthcare, their diagnosis of cancer is more likely to be made at a later stage, and thus they are more likely to have worse health outcomes and reduced survival time. Currently, the emphasis by most foundations and the Federal government is geared towards treatment innovations and screening. While treatment is important, there is a need for improved access to health care as well as targeted screening and other public health strategies for Blacks and Hispanics to improve their colorectal health outcomes.

The Affordable Care Act (ACA) passed on March 23, 2010, was designed to increase coverage as well as improve the quality of the coverage. The increased coverage was achieved through a mandate that all private insurance cover CRC screening according to national guidelines free of charge, and the establishment of the exchange market place and the expansion of Medicaid. While the improved quality was by guaranteeing that all individuals have certain levels of accessibility to necessary health services, which included improved treatment options and preventive care without co-pays. Some studies have shown the effect of access to care on various subgroups, but with the implementation of the Affordable Care Act in 2010, this gives a clear-cut demarcation in time to be able to compare and assess the impact of increased access to health care coverage on colorectal cancer mortality, especially on those in the lower socio-economic class by looking at states that expanded Medicaid. Unfortunately, states lagged in their expansion efforts and this did not occur immediately following the 2010 Law. However, the
mandate that existing insurance cover CRC screening without charge went into effect immediately.

The Purpose of the study is to show if there was an impact on the declining mortality rate of colorectal cancer in general, among Hispanics and Blacks as compared to whites following the implementation of the ACA. A simple line chart (fig 1.1) of the annual colorectal mortality rate of Whites, Blacks and Hispanics, and the uninsured rate from 1990 to 2013 for all 25 states used for the analysis shows a continuous decline in the CRC mortality rate for both Blacks and Hispanics as well as Whites from 1990 to 2013, but with the CRC mortality rate for both Blacks and Hispanics being persistently higher than that of Whites throughout. Using the same data from the line chart, the gap in mortality rate between Blacks, Hispanics and Whites appears to be maintained annually as the rates decline, but then appears to narrow after 2010 (fig 1.2). The White CRC mortality rate declines and by 2008 is about at the level of the uninsured rate annually after that. This may imply that with increased access and affordability of screening there could be a narrowing and possibly elimination of the gap between Blacks, Hispanics and Whites. The trend analysis using the annual data from the 25 states from 1990 to 2013 for Whites, Blacks and Hispanics for ten years into the future to 2023 (fig 1.3), also shows that the Black and Hispanic CRC mortality rate continues to decline but still lags that of White CRC mortality decline, which gets into the single digits by 2023, but it shows a slight narrowing of the gap between Blacks and Hispanics as compared to whites after 2010, the year the ACA was passed.
**Fig 1.1**

**CRC MORTALITY AND UNINSURED RATE**
- Blue line: White CRC mortality rate
- Orange line: Black & Hispanic CRC mortality rate
- Grey line: Uninsured rate

**Fig 1.2**

**Black, Hispanic and White CRC Mortality rate 1990-2013**
- Blue line: White mortality rate
- Orange line: Black mortality rate
This study will describe one of the factors that may be leading to the varying rate of decline for both minorities as compared to whites, and demonstrate if Black and Hispanic colorectal cancer survival rates vary by state; and any change in the decline in colorectal mortality rates for minorities compared to Whites after 2010. Minorities may still have higher rates, but is their rate falling relatively faster in the US as compared to whites?

The study will answer the question; what association can be found between the expanded health care coverage for colorectal cancer screening following the ACA (2010) and colorectal cancer mortality? Does the disparity pattern in CRC mortality among whites and minorities change after 2010?
CONCEPTUAL MODEL

Fig 1.4  The cancer care continuum model, IOM (iom, 2013)

Fig 1.5  A conceptual model for Black, Hispanic-White disparities in colorectal cancer incidence, screening, and outcomes.

*Only the domains from left side of the Cancer Care Continuum Model are included in this conceptual model. These are the domains relevant to this thesis.
The conceptual model in this study is based on two frameworks as depicted in the IOM Source of Disparities in Care model (Fig 1.4) and the conceptual model for Black, Hispanic-White disparities in colorectal cancer incidence, screening, and outcomes (fig 1.5). These frameworks have divided the source of racial disparities into the level of the patient, provider level and health care system-level factors. Patient-level factors include attitudes towards preventive measures like CRC screening among different ethnic groups, and the patient preferences and demographic factors that determine whether a patient utilizes a particular health care service. Another patient-level factor is the geographic location where the patient resides and how accessible health care providers are to that location. Provider-related characteristics are certain features specific to the techniques and practices of individual providers as well as the location of these providers, that could affect whether a patient receives a healthcare service. System-level contributors are the aspects of the healthcare system, such access and affordability of insurance or Medicaid expansion that affect a patient’s ability to access a health care service. The IOM Disparities in Care Model is not specific to a disease state or medical service. However, it is a hypothesis generating framework that can guide the exploration of any disparity. The Conceptual Model for Black, Hispanic-White Disparities in Colorectal Cancer Incidence, Screening, and Outcomes is a framework partly built on the IOM cancer care continuum model (Fig 1.5). The patient-level, provider-level, and system-level domains in the model interact with one another to influence patient and provider behavior and patient care. For example, an individual’s financial status, where they live and language barrier (patient-level factor) may impact the healthcare system (system-level factor) he has access to, which, in turn, may determine the availability of CRC preventive and diagnostic services. Alternatively, a provider’s inclination to recommend a screening test to an eligible patient (provider-level factor)
may be influenced by system level factors such as reminders from the clinic due to inadequate reimbursement or request rejected or denied by insurance provider.  

The disparities at the system-level will be the focus of this thesis as this would impact ones’ access to preventive measures, rate of detection, and diagnosis, as well as eventual treatment and thus survivorship and mortality rate of this cancer. Prevention of CRC is affected by one’s socio-economic status. Among the risk factors for colorectal cancer is vitamin D deficiency. Vitamin D is one of the protectors against CRC as research has shown that there is a negative correlation between the amount of sunlight exposure and CRC mortality. With vitamin D diet deficiency, common amongst Americans, the sun is the best alternative source, and thus those living in the Metropolitan areas receive less sunlight due to the shadows from the high-rise buildings, compared to rural places. Darker skin is less able to absorb vitamin D than lighter skin, a reason hypothesized for greater cancer incidence among Blacks. Other socio-economic factors such as education, obesity and financial status which determines one's ability to afford access to preventive measures like screening, play a role in one’s outcome.

Detection disparities in either polyps (which could be precursors of CRC) or early stage CRC is another factor that could impact the outcome. The rate of colorectal screening and those factors which determine the rate at which each ethnic group has access to it, as well as their attitudes to screening would also affect the mortality rates.

Finally, the diagnosis and treatment and the factors that influence these determine survivorship and mortality to CRC. The stage at which CRC is diagnosed would affect not only the treatment available, the cost of the treatment and ultimately survivorship and mortality. With later stage diagnosis, there is a likelihood of reduced survival chances. The system-level factor plays a
major role in CRC outcome as it affects one's ability to access the health care system in the first place.

There is an interplay of the patient, provider and system-level factors on the prevention, detection, and diagnosis of CRC, as any disparity at the patient, provider or system-level would affect the prevention, diagnosis, and treatment of CRC and thus the survivorship and the mortality rate. Due to the limitation of the scope of this study in its inability to address the patient and provider level factors, this paper would be assessing the disparities at the system-level factors, which is access to care which for this paper is measured by the insured rate and thus what impact the uninsured rate has on Black and Hispanic CRC mortality compared to Whites CRC mortality rate.
METHODS AND PROCEDURES

With the implementation of the Affordable care act (ACA) in 2010, it increased coverage for many who did not have coverage prior to its implementation. This was achieved through the creation of the exchanges with subsidies to assists with their premiums for those who qualify. Increased coverage was also achieved through the expansion of Medicaid by the states, except for 19 states mostly in the mid-west and south that did not expand. The ACA also included an individual and employer mandate which further helped to increase coverage. In addition, preventive services such as cancer screening was mandated as part of all private insurance plane coverage without a co-pay, making it more affordable and accessible.

With Blacks and Hispanics less likely to have insurance compared to Whites and thus less likely to be able to afford screening, thus their cancers being detected at later stages resulting in worse outcomes and higher mortalities. With the increased coverage and access to colorectal screening from the ACA one would expect a narrowing of the gap in mortality rate between Blacks, Hispanics and White, since there is a disparity in both health coverage and access to screening there is a greater proportion of Blacks and Hispanics that could gain access to colorectal screening as compared to Whites.

The research is a non-experimental, cross-sectional study, and quantitative. This study used secondary data on colorectal cancer mortality from the period of 1990 to 2013 for 25 states in the United States which had data for White, Black and Hispanic populations. Mortality data provided each year by the National Vital Statistics System at the National Center for Health Statistics of the Centers for Disease Control and Prevention, also by the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) Program. Population counts for denominators are based on
Census populations as modified by NCI. The data includes all races, ages, and sexes, with the minorities of interest defined as Blacks and Hispanics. The uninsured rate for the 25 states derives from various sources, including literature review for years 1990 to 1996\textsuperscript{32} and the United States Census Bureau 1999 for years 1997 to 1999 and United States Census Bureau 2013 for years 2000 to 2013. The uninsured rate covered the years from 1990 to 2013 for the 25 states, and was made up of all ages, ethnic groups and both sexes.

Two time periods were identified (early and later period) and mean mortality and insurance rates were calculated over these two intervals. Regression analysis was performed on the two-time intervals of data stacked over two periods (early and later periods), with a binary time indicator variable to differentiate the early and late periods. The regression included the CRC mortality rate for whites and the CRC mortality rates for Blacks and Hispanics for each state in each period (4 observations per state) as the dependent variable, a total of 100 observations. Regressors included the uninsured rate for all populations in each time interval for each state (2 unique observations per state), an indicator of minority versus white race/ethnicity (50 observations=1, rest=0), and a time indicator (later time=1, earlier=0). The time and minority indicators were interacted to test whether minority CRC mortality rates fell after 2010 as compared to Whites, holding constant access to care, the overall trend in CRC mortality, and the overall minority effect associated with CRC. Defining the time intervals as periods pre- and post- 2010, the main hypothesis was to assess whether these CRC mortality outcomes changed significantly pre-post the 2010 implementation of the ACA, and whether there were differential effects over time for minorities versus white race/ethnicity. All people of all races or ethnicities available in the SEER data were included.
The conceptual model for Black, Hispanic-White disparities in colorectal cancer incidence, screening, and outcomes (fig 1.2) was used. This framework has divided the source of racial disparities into the level of the patient, provider level and health care system-level factors.\(^\text{35}\)

Patient-level factors include attitudes towards preventive measures like CRC screening among different ethnic groups,\(^\text{28}\) and the patient preferences and demographic factors that determine whether a patient utilizes a specific health care service, and the geographic location were the patient resides and how accessible health care providers are to that location. Provider-related characteristics are certain features specific to the techniques and practices of individual providers as well as the location of these providers, that could affect whether a patient receives a healthcare service.\(^\text{22}\)

System-level factors are aspects of the healthcare system that affect a patient’s ability to access a health care service, such as access and affordability of insurance as well as Medicaid expansion that affect a patient’s ability to access a health care service. The Conceptual Model for Black, Hispanic-White Disparities in Colorectal Cancer Incidence, Screening, and Outcomes is a framework partly built on the IOM cancer care continuum model (Fig 1.4). The patient-level, provider-level, and system-level domains in the model interact with one another to influence patient and provider behavior and patient care. The thesis examined the system-level, which consists of aspects of the healthcare system geared towards access to it, and its affordability. The access to the healthcare system can be either through insurance coverage, Medicaid, Medicare or Tricare, and this determines one’s ability to take advantage of preventive measures such as colorectal screening. With the implementation of the ACA which included expansion of insurance coverage through premium assistance for those who qualify in the exchanges, along with Medicaid expansion. Therefor increasing access and affordability for many to the healthcare system, and with the mandated preventive measures such as colorectal screening without co-pay would also
increase its access. One possibility is that with more people having access to both the healthcare system and colorectal screening, and with more minorities initially without access prior to 2010, there is more room or a greater opportunity for a greater decline in the uninsured rate and a greater number having access to colorectal screening as compared to whites, thus a greater decline in minority CRC mortality compared to that of whites. The increased access to care and thus CRC screening may therefore result in a narrowing of the gap in the rate of decline in CRC mortality rate for minorities as compared to whites.

The geographic information system (GIS) analysis and cartographic displays were performed with the software QGIS version 2.18.2. Geographic Coordinate Reference Systems WGS 84 (EPSG = 4326) was used, with a scale of 1:11,401,397. Using the highest mean value for minority CRC mortality as the upper cutpoint as they had the highest value, a quantile classification scheme map series with five equal intervals and landscape for missing data was used to create maps for white and minority CRC mortality and uninsured pre - and post 2010 (figs 1.6, 1.7 and 1.8). The same cutpoint used across all maps makes the maps on CRC mortality for whites and minorities pre - and post 2010 comparable.

The data from the 25 states with all three ethnic groups, CRC mortality rate divided into white and minority represented as Black and Hispanic is the dependent variable and Race, Time, race*time, and uninsured are independent variables. The white CRC mortality rate per 100,000 of all ages with a mean for the early period of 19.92/100,000 and sdev of 2.22, the minimum being 17.42/100,000 and maximum of 23.40/100,000. The late period mean was 15.06/100,000 and sdev of 1.43, with a minimum of 12.00/100,000 and maximum of 17.85/100,000. The minority CRC mortality rate per 100,000 had in the early period a minimum of 21.94/100,000, a maximum of
32.33/100,000 and a mean of 27.87/100,000 with a sdev of 2.83. In the late period the minority CRC mortality rate had a minimum of 14.35/100,000, a maximum of 26.43/100,000 and a mean of 20.92/100,000 with a sdev of 2.94.

A binary race indicator (MIN_DUM), which was from states with both Black and Hispanic data over the two periods was represented with a dummy indicator of 1, thus 50 observations and a minimum and maximum of 1 for both the early and late period, and a mean of 0.5 and sdev of 0.51 for both periods as well. The time indicator in years was represented as 0 if between 1990 and 2009 (early period) and 1 if between 2010 and 2013 (later period), with 50 observations. The early period had a minimum, maximum, mean and sdev of 0, while the later period had a minimum and maximum of 1 and mean of 1 and sdev of 0.

The uninsured rate also from the same 25 states as the CRC mortality and was per 100,000, had in the early period a minimum of 4.40/100,000, maximum of 26.10/100,000 and a mean of 15.9/100,000 with sdev of 4.15. The later period minimum for the uninsured rate was 3.70/100,000, maximum was 22.10/100,000 and mean 13.81/100,000 while the sdev was 3.9.

The interaction between time and the binary race (Black and Hispanic) indicator, had 50 observations, with a minimum, maximum, mean and sdev for the early period of 0, while the later period had a minimum of 0, maximum of 1, mean of 0.25 and sdev of 0.44.
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Table showing regression analysis for two-time intervals of data stacked over two periods, number of observations 100, adjusted R square 0.78, interval 95%, p-value 0.05.

*Data used was from 25 states of the United States which had CRC mortality and uninsured data available for Blacks, Hispanics and Whites.

RESULTS

**Fig 1.6**

Black and Hispanic mortality rate
Fig 1.7

white mortality rate

2009 White colorectal Ca mortality rate

2013 White colorectal Ca mortality rate

Legend
white cancer mortality
植苗 (2)
6.0 - 6.6
5.5 - 6.1
5.0 - 5.6
4.5 - 5.1
4.0 - 4.6
3.5 - 4.1
3.0 - 3.6
2.5 - 3.1
2.0 - 2.6
1.5 - 2.1
1.0 - 1.6
0.5 - 1.1
Missing data

Fig 1.8

Uninsured rate

2009 Uninsured rate by state

2013 Uninsured rate by state

Legend
per post uninsured
植苗 (2)
8.0 - 8.6
7.5 - 8.1
7.0 - 7.6
6.5 - 7.1
6.0 - 6.6
5.5 - 6.1
5.0 - 5.6
4.5 - 5.1
4.0 - 4.6
3.5 - 4.1
3.0 - 3.6
2.5 - 3.1
2.0 - 2.6
1.5 - 2.1
1.0 - 1.6
0.5 - 1.1
Missing data
<table>
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<th>Early period Per 100,000</th>
<th>Later period Per 100,000</th>
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<th>sdev later period</th>
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</thead>
<tbody>
<tr>
<td>White mortality (wm)</td>
<td>Colorectal cancer mortality per 100,000 for all ages for Whites in 25 states</td>
<td>50</td>
<td>17.42</td>
<td>12</td>
<td>2.22</td>
<td>1.43</td>
</tr>
<tr>
<td>Black &amp; Hispanic mortality (bhm)</td>
<td>Colorectal cancer mortality per 100,000 for all ages for Blacks and Hispanics combined in 25 states</td>
<td>50</td>
<td>21.94</td>
<td>14.35</td>
<td>2.83</td>
<td>2.94</td>
</tr>
<tr>
<td>uninsured</td>
<td>uninsured rate per 100,000 for all races, gender and ages</td>
<td>50</td>
<td>4.40</td>
<td>3.70</td>
<td>4.15</td>
<td>3.9</td>
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</tbody>
</table>
The distribution of the Black and Hispanic CRC mortality rate by states in 2009 (fig 1.6), shows a higher rate (23.3-32.3) across all the states except New York, Massachusetts and Connecticut which was (17.5 -23.3), this is also prior to the implementation of the ACA. By 2013 three years into the implementation of the ACA the CRC mortality rate across most of the states had dropped (17.5-23.6) except Oklahoma, Kansas, Arkansas, Tennessee, Mississippi, Alabama and Illinois which remained at (23.3 – 32.3), most of these states did not fully implement all aspects of the ACA.
The distribution pattern for the Black and Hispanic CRC mortality rate pre-and post-2010 when the Affordable Care Act was implemented, had higher rates concentrated mostly in the southern states, these are mostly states that did not fully implement the ACA by not expanding Medicaid thus leaving a number of the working poor without insurance and most likely CRC screening, and Massachusetts having the lowest rate (0.00 – 5.8). It is not surprising Massachusetts has the lowest rate as they passed their health care law in 2005, thus expanding coverage.

In 2009 the White CRC mortality rate across all 25 states was mostly between 17.5 -23.3 except for Oklahoma and Georgia that was between 11.6 – 17.5 (fig 1.8), and by 2013 only Arkansas was between 17-23.3 range, while Massachusetts was the lowest (0.00 - 5.8).

The data stacked over two periods regression analysis done showed that, over both periods together, a higher state uninsured rate was associated with a higher state CRC mortality rate, but this was not statistically significant (p = 0.294). Over both periods together, the CRC mortality rate for Hispanics and Blacks was higher than that for whites, by 7.94 deaths per 100,000, and this was statistically significant. There was a reduction in the average CRC mortality rate by 4.73 deaths per 100,000 over the time periods for everybody, and this was statistically significant (p = 0.000).

However, in the later period, the Black and Hispanic CRC mortality rate fell by an additional 2.073 deaths per 100,000 as compared to the overall decline and this was significant (p = 0.035). Thus, there was a larger decline in the CRC mortality rate for Blacks and Hispanics compared to whites over the two periods, which suggests that the passage of the ACA may have reduced disparities in CRC mortality among minorities as compared to whites.
LIMITATIONS

A major limitation was the lack of complete data for the uninsured rate for Blacks and Hispanics alone from 1990 to 2013 and that for Whites for the same period for all 50 states. Another limitation was the fact that only 25 states had CRC mortality data for Whites along with Blacks and Hispanics, thus limiting the size of data available to 100 instead of 300 had there been data from all 50 states for all three groups.

The mortality rate and the uninsured rate data only included three years following the passage of the affordable care act (2010 -2013), so the full impact of the declining uninsured rate on CRC mortality could not be truly measured. The findings may suggest that a lower uninsured rate is associated with a decline in the mortality rate. This decline was already occurring over the years from 1990, and there is not enough statistical information to yield statistically significant results tying uninsured rate to this decline. Another limitation is the lack of health insurance status by race or ethnicity in the states.

Another limitation is that we are assuming the SEER data for CRC mortality is accurate, and the subject’s deaths are specific to CRC.

Another limitation is the fact we had to hold uninsured rates constant as failure to do so could have resulted in omitted variables bias on the minority effects, assuming that minority uninsured rates differed from whites. Some variables known to affect survival such as treatment regimen, comorbidities, and risky behavior were not included, as these were found to affect the survival outcomes by other studies.27
Future analyses should attempt to determine what if any insurance effects were present for the different racial/ethnic groups. A three-way interaction between uninsured by group, and time could also determine whether the insurance effects were stronger for one group than for another, which would have interesting policy implications.

DISCUSSION

There has been a decline in the uninsured rate in the United States with each passing year, as shown by the United States Census Bureau. The findings from this study are consistent with that, though states that fully implemented the ACA showed a greater decline comparing data from 2009 to that of 2013.\textsuperscript{7,10,13} Possibly due to the fact that CRC screening was more accessible in these states as well.\textsuperscript{26}

The current surveillance data shows that Blacks have a higher incidence rate for CRC compared to other races,\textsuperscript{2,20,21} while Hispanics have an earlier onset and more advanced disease as compared to other races.\textsuperscript{21} Now with Black and Hispanics being more likely to be uninsured\textsuperscript{3,1} and so having less access to affordable CRC screening. The reduced access to CRC screening for Blacks as compared to whites may be contributing to the persistent gap in CRC mortality decline before the implementation of the ACA. The study showed a reduction in the CRC mortality over time in 2013 as compared to 2009 by 4.73/100,000 which was significant ($p = 0.00$), with a greater decline in minority CRC mortality by 2.073/100,000 as compared to whites over the two-time periods. Due to a greater number of minorities as compared to whites being uninsured, and thus are less likely to have access to CRC screening before the implementation of the ACA in 2010 (early period). It is not
surprising then that with the implementation of the ACA (later period) which may have made CRC screening more accessible with increased insurance coverage, minorities had a greater decline compared to whites.

The stage at which the diagnosis of CRC is made impacts treatment options and outcomes, therefore it is not surprising Blacks and Hispanics have a higher CRC mortality rate as compared to whites. The states with a higher uninsured rate and thus most likely reduced access to CRC screening for earlier detection were found to have higher minority CRC mortality rate in this study (23.3 – 32.3/100,000) compared to states with much lower uninsured rates. The states with much lower uninsured rates had minority CRC mortality rates (5.8 - 11.6) which were commensurate with that of whites (5.8 - 11.6). This was similar to the findings by other publications in which those without insurance had much later stages of CRC at diagnosis, and thus an expected higher mortality rate.

This study thus suggests that the increased access to insurance and thus CRC screening by minorities did improve their CRC mortality rate. Now if the access to insurance and thus CRC screening amongst minorities is made commensurate to that for whites, this may reduce or eliminate the gap in CRC mortality rate decline for minorities as compared to whites.

**SUMMARY AND CONCLUSION**

The lower uninsured rate is weakly associated with a decline in mortality rate comparing the rates in 2009 with that of 2013. Over the twenty-four-year period from 1990 to 2013, there has been a steady decline in the CRC mortality rate for Blacks, Hispanics, and Whites.
There has also been a decline in the uninsured rate in 2013 as compared to 2009, with a greater decline in most of those states, that expanded Medicaid following the implementation of the ACA in 2010. The impact of the decline in the uninsured rate on CRC mortality rate is still uncertain due to there not being enough statistical information to yield statistically significant result and the short duration of its measurement. This is because the expansion of Medicaid in most states occurred within the last year or two of this data.

Though there has been this decline in CRC mortality, that of Black and Hispanics still lag, compared to whites over the twenty-four years. The factors for the lag could be several, of which access to insurance was considered with this paper. Past publications had shown that increasing insurance coverage for Blacks did not necessarily improve their CRC outcome, but with greater awareness and access to screening this study has shown that this might not be the case. States with higher uninsured rates, most of which are the southern states appear to have a higher CRC mortality rate for Blacks and Hispanics as compared to those with a lower uninsured rate, mostly in the northeast. A case in point is Massachusetts with one of the lowest uninsured rate, the CRC mortality rate for Whites, Blacks and Hispanics is also one of the lowest and without the gap as that for Blacks and Hispanics track that of whites closely. With Massachusetts, having implemented their health care law in 2006 thus resulting in more than 95% of the population being insured and thus having access to CRC screening giving more time for its impact to be seen, as compared to the ACA which was implemented in 2010 and the implementation of the Medicaid expansion aspect did not take effect till 2012.

The decline in mortality rate has been put in motion long before the decline in uninsured rates occurred. This decline has been attributed to several other factors such as such as early detection
with better screening techniques, increased awareness amongst the general population and more advanced and effective treatment methods.\textsuperscript{30} Other factors explaining the decline is a change in diet, such as reduced consumption of cured and smoked meat, possibly resulting in lower carcinogenic nitrosamines exposure. The possible gastrointestinal microbiome or floral changes following the wide spread use of antibiotics, as in the case of decreasing Helicobacter pylori. Also, playing a role may be the use of drugs like nonsteroidal anti-inflammatory including aspirin, hormone-replacement therapy, and statins, as these drugs have been associated with reduced colorectal neoplasia.\textsuperscript{30}

One thing remains, for one to access these new and improving treatment options as well as placement on antibiotics and so on, one needs to be able to access the health care system. To access the system, one’s insurance status comes to play, this may account for the gap in mortality rate decline for Blacks and Hispanics as compared to Whites. Blacks and Hispanics persistently are more likely to be uninsured at higher rates compared to Whites.\textsuperscript{3,1}

Also, the stage at which a diagnosis of CRC was made also affects the mortality rate. Early detection results in better outcomes and those with insurance are thus more likely to present at earlier stages. Lack of insurance coverage for a long time has been linked to disparities in health and health care, including for the treatment of colorectal cancer.\textsuperscript{23} This study may point to the fact that when healthcare is accessible and affordable to more people they are more inclined to utilize the services available including preventive measures, such as CRC screening.

In conclusion, the fact that there was a greater decline in the mortality rate for minorities as compared to Whites in the later period, may suggest that the passage of the ACA which not only increased access, but made screening a mandated coverage by insurance plans without co-pay
made a difference. The greater decline in CRC mortality for minorities as compared to whites may be due to the fact that in the first place there were more minorities uninsured and thus less likely to have access to preventive measures as compared to whites, giving more room for decline amongst this group. It does appear race does have an impact on CRC mortality rate, with minorities faring worse.

The current debate as to the fate of the ACA, repeal or not to repeal, and all the replacement options put forward by the party in control of Congress are geared towards reducing cost but in so doing would reduce the number of people insured, and nineteen states are yet to expand Medicaid. This debate keeps the chance of a further reduction in the number of uninsured and an increase in the number of people with access to preventive measures such as CRC screening in question. Unfortunately, a majority of the non-expansion states are in the south, where a large proportion of Blacks and Hispanics reside. Thus, the disparity in insurance status, access to health care and colorectal cancer screening and thus mortality rate for CRC may not make a further change.

If the ACA can remain, along with the mandated insurance coverage of preventive measures and screening without co-pays, with the remaining states expanding Medicaid, then the uninsured rate would be further reduced and access to screening increased. Or if there is a replacement that further reduces the uninsured rate with eventual universal coverage. It would be helpful for further research to see what the long-term effect of universal coverage and increased access to colorectal screening, especially now with the use of cologuard, which is a less invasive method of screening, has on CRC mortality rate. To then assess if the gap between Black, Hispanic and White mortality rate continues to decline or is eliminated.
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