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Temporal Trends in Geographic and Sociodemographic Disparities in Colorectal Cancer Among Medicare Patients, 1973–2010

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Abstract

Purpose—Colorectal cancer (CRC) incidence and mortality in the United States have steadily declined since the 1980s, but racial and socioeconomic disparities remain. The influence of geographic factors is poorly understood and may be affected by evolving insurance coverage and screening test uptake. We characterized temporal trends in the association between geographic and sociodemographic factors and CRC outcomes.

Methods—We used the 1973–2010 SEER-Medicare files to identify patients aged ≥65 years with and without CRC. Beneficiary residential ZIP codes were used to extract local-level data. We constructed multivariable logistic regression models for CRC incidence and mortality using geographic and sociodemographic variables in 4 time periods: 1)1973–1997, 2)1998–2001, 3)2002–2006, and 4)2007–2010.

Findings—We analyzed 1,093,758 records, including 336,321 CRC cases. Compared to urban residence, small rural residence was strongly associated with increased CRC incidence (OR 1.50, 95% CI: 1.43–1.57) and mortality (OR 1.35, 95% CI: 1.26–1.45) in 1973–1997, but the associations diminished by 2007–2010 (OR 1.09, 95% CI: 1.04–1.15 for incidence; OR 1.10, 95% CI: 1.01–1.20 for mortality). The disparity between blacks and whites increased over time for both incidence (OR 1.09, 95% CI: 1.05–1.13 in 1973–1997 vs OR 1.32, 95% CI: 1.27–1.37 in 2007–2010) and mortality (OR 1.22, 95% CI: 1.16–1.28 in 1973–1997 vs OR 1.34, 95% CI: 1.26–1.42

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in 2007–2010). High socioeconomic status was associated with greater incidence and mortality in 1973–1997, but it became protective after 1998.

Conclusions—Although disparities persist among Medicare beneficiaries, the relationship between geographic and sociodemographic factors and CRC incidence and mortality has evolved over time.

Keywords

colorectal cancer; geography; health care disparities; race/ethnicity; rural

Colorectal cancer (CRC) is the third most commonly diagnosed cancer among both men and women and the second leading cause of cancer death in the United States,¹ but the risk of disease can be greatly reduced through lifestyle modification and screening. Screening with both the noninvasive fecal occult blood test (FOBT) as well as colonoscopy have been shown to reduce CRC incidence and mortality.^{2–4} The FOBT screening strategy requires that positive tests are followed up by colonoscopy, and colonoscopy can remove premalignant polyps in addition to detecting cancer. Modeling suggests that half of the decline in incidence and mortality since the 1980s can be attributed to screening.⁵ However, not all groups have benefitted equally from prevention and treatment, and sociodemographic factors such as race/ethnicity and socioeconomic status are known to influence CRC outcomes.^{6–13} The role of geographic factors in CRC is not well understood, and the only investigations in the US to date have been conducted at the state level.^{14–17} Access to different methods of screening have also varied over time, as Medicare coverage for FOBT and flexible sigmoidoscopy began in 1998 and coverage for colonoscopy in average risk individuals started in July 2001. Since screening plays a key role in CRC outcomes, we hypothesized that geographic factors which influence access to screening—specifically rural/urban residence and physician supply—would affect both CRC incidence and mortality. The relationship between these geographic factors and CRC outcomes may also evolve with changes in screening coverage. The aim of this study was to investigate temporal trends in CRC incidence and mortality with respect to geographic and sociodemographic factors in a nationally representative population of older adults.

Methods

Study Design

We performed a case-control study using the 1973–2010 Surveillance, Epidemiology, and End Results (SEER)-Medicare linked database.¹⁸ Cancer patients were identified from the Patient Entitlement and Diagnosis Summary File (PEDSF) and beneficiaries without cancer were identified from the Summarized Denominator (SUMDENOM) file. Cases included all individuals diagnosed with CRC during this period. The control group combined a random 5% sample of Medicare beneficiaries without cancer living in SEER regions and a random 5% sample of patients in the SEER-Medicare database who were diagnosed with cancers other than CRC. The control group was designed to represent all Medicare beneficiaries without CRC. We classified cases into 4 time periods based on year of diagnosis to reflect evolving screening and reimbursement practices: 1) 1973–1997, prior to Medicare coverage

of CRC screening; 2) 1998–2001, coverage of fecal occult blood testing and flexible sigmoidoscopy; 3) 2002–2006, coverage of colonoscopy for average-risk individuals; and 4) 2007–2010, most recent period with the highest uptake of screening. Controls were frequency matched to cases by time period and assigned to a time period during which they were alive for analysis. Individuals who were younger than 65 years of age at the time of CRC diagnosis or Medicare enrollment were excluded.

Geographic variables were derived using the subject's ZIP code of residence as listed in the relevant SEER-Medicare file. Rural/urban status was categorized as urban, large rural, or small rural, as defined by the Rural-Urban Commuting Area (RUCA) codes.¹⁹ Local geographic and sociodemographic data, including primary care and specialist physician supply (defined as physicians per 100,000 residents), population density, travel time to work, median household income, and educational level at the Primary Care Service Area (PCSA) level, were extracted from the Dartmouth Atlas of Health Care²⁰ and categorized into quartiles. Compared to counties, PCSAs provide more granular and relevant data because the areas are defined by health utilization rather than arbitrary geopolitical boundaries with little or no epidemiologic meaning.²¹ PCSA-level specialist supply measures availability of all specialists and does not provide data on particular specialists who might be involved in the diagnosis and treatment of CRC, such as gastroenterologists, surgeons, oncologists, and radiation oncologists. Educational level was measured by the percentage of the PCSA population with at least 12 years of education. PCSA data from the 2000 US Census and 2000–2001 American Medical Association (AMA) and American Osteopathic Association Masterfiles were used for the 1973–2001 analyses, and data from the 2010 Census and AMA files were used for the 2002–2010 analyses. This study (protocol #7946) was approved by the Cancer Consortium Institutional Review Board at the Fred Hutchinson Cancer Research Center and University of Washington.

Predictors of Interest

We evaluated 10 potential predictors of CRC incidence and mortality, including 5 geographic and 5 sociodemographic factors. We chose rural/urban residence and physician supply within a PCSA as the primary variables of interest because the former is an intuitive conceptual model for geography and the latter is a proxy for health care access and utilization. We also investigated the associations with race/ethnicity, education, and median household income as secondary outcomes. For each variable, we examined temporal trends in these associations across the 4 time periods of interest.

Statistical Analysis

We developed multivariable logistic regression models to identify potential predictors of CRC incidence and mortality. Variables were evaluated by stepwise backward elimination and retained in the final models if the *P* values were less than .05. Temporal trends were assessed using Wald tests of interaction terms between a categorical time variable and independent variables as well as pairwise contrasts between consecutive time periods for each variable. Results were considered statistically significant if the 2-sided *P* value was less than .05. All data were analyzed using Stata version 13 (StataCorp, College Station, TX).

Results

Study Population

A total of 1,093,758 individuals were included in the analysis, with 336,321 CRC cases, 103,813 CRC deaths, and 757,437 controls (Table 1). The median age overall was 75 and the median age for diagnosis of CRC was 79. The study population was 56.0% female and 81.9% white. By PCSA, the median percentage of population with at least 12 years of education was 57.5% and the median household income was \$60,009 USD. In terms of geography, 84.4% of individuals lived in urban areas, 7.6% lived in large rural areas, and 8.0% lived in small rural areas. The median PCP and specialist supply (per 100,000 residents) in a PCSA were 70 and 112, respectively. Table 2 shows the population characteristics of all beneficiaries living in urban, large rural, and small rural areas. Compared to rural areas, urban areas had a higher percentage of white residents as well as higher median educational level, household income, and PCP and specialist supply in both the 2000 and 2010 Census.

Geographic Factors

Relative to urban areas, residents of small rural areas had a higher odds of CRC incidence in 1973–1997 (OR 1.50, 95% CI: 1.43–1.57) (Table 3). The strength of this association diminished after 1998 but has remained stable since 2002 (OR 1.09, 95% CI: 1.04–1.15 in 2007–2010). The strength of the association between small rural area residences and mortality has also decreased over time (OR 1.35, 95% CI: 1.26–1.45 in 1973–1997 vs. OR 1.10, 95% CI: 1.01–1.20 in 2007–2010) (Table 4). The associations between large rural areas and outcomes follow a similar pattern but are attenuated compared to that of small rural areas (Tables 2 and 3). Areas with high population density had higher CRC incidence and mortality, and this association also diminished over time (Tables 2 and 3).

Individuals living in PCSAs with the highest quartile of specialists per capita had lower CRC incidence compared to those living in areas with the lowest quartile in 1973–2001 (OR 0.88, 95% CI: 0.85–0.91 in 1973–1997) (Table 3). This association diminished over time, and after 2002 there was no statistical difference between the top and bottom quartiles (OR 0.97, 95% CI: 0.92–1.02 in 2007–2010). Similarly, high specialist supply was associated with lower mortality in 1973–2006 (OR 0.84, 95% CI: 0.79–0.89 in 1973–1997) but not in 2007–2010 (OR 0.92, 95% CI: 0.85–1.00) (Table 4). High primary care physician (PCP) supply was associated with a slight reduction in incidence in 1973–1997 (OR 0.94, 95% CI: 0.90–0.97). The association between PCP supply and incidence was not statistically significant within each of the 3 time periods after 1998, but there was a statistically significant downward trend in ORs ($P < .001$) when examining the interaction term with time. There was no significant association between PCP supply and mortality in any time period.

Sociodemographic Factors

Compared to whites, blacks had higher CRC incidence and mortality in all 4 time periods, and this disparity worsened over time (Tables 2 and 3). The OR for incidence for blacks increased from 1.09 (95% CI: 1.05–1.13) in 1973–1997 to 1.32 (95% CI: 1.27–1.37) in

2007–2010. The OR for mortality increased from 1.22 (95% CI: 1.16–1.28) to 1.34 (95% CI: 1.26–1.42) over the same interval. On the other hand, both Asians and Hispanics had significantly lower incidence and mortality than whites throughout the study period.

The relationships of both education and median household income and CRC outcomes evolved over time (Tables 2 and 3). Individuals living in areas with the highest educational attainment were much more likely to be diagnosed with CRC in 1973–1997 (OR 1.54, 95% CI: 1.48–1.59) than those in the least educated areas, but in 2007–2010 high educational level had become marginally protective against CRC (OR 0.97, 95% CI: 0.93–1.00). The ORs of incidence for the wealthiest quartile of PCSAs were 1.32 (95% CI: 1.27–1.38) in 1973–1997 and 0.90 (95% CI: 0.86–0.94) in 2007–2010. Similar trends were seen over time for CRC mortality.

Discussion

In this national study of Medicare beneficiaries, rural residence was associated with increased CRC incidence and mortality, while high specialist supply was associated with reduced CRC incidence and mortality in earlier, but not later periods. In addition, we found growing disparities between blacks and whites and a reversal in the relationship between socioeconomic status and CRC outcomes.

Studies at the state level have variably found an increase¹⁴ or a decrease¹⁵ in CRC incidence among rural residents, and only one investigation has examined CRC mortality and found higher rates in rural areas.¹⁶ Not only have the findings been inconsistent, but the limited geographic scope of these state-level studies prevents a full characterization of the relationship between rural/urban residence and CRC across the US. Our analysis shows that rural residents have higher CRC incidence and mortality at the national level. Furthermore, small rural areas had worse outcomes than large rural areas in every period, which supports the presence of a gradient within rural areas. These findings suggest that smaller rural communities may especially benefit from targeted interventions for screening and possibly treatment.

Although the disparity in incidence and mortality between rural and urban regions decreased after coverage for FOBT/sigmoidoscopy began in 1998, it did not improve appreciably after 2001, when coverage had extended to colonoscopy. A main reason for the continued disparity may be the lower uptake of endoscopic screening among rural residents. A national survey from 2005 showed that the up-to-date screening rate was 54% in urban areas, 48% in all rural areas, and 45% in remote rural areas.²² This difference was entirely explained by a lower endoscopic screening rate in rural areas, despite a slight increase in rural FOBT use, coupled with a decrease in urban FOBT use. Multiple barriers to screening and endoscopic screening in particular, including geographical access, may disproportionately affect rural residents. We adjusted for known relevant variables such as income, education, travel time, PCP supply, and specialist supply. Insurance status was less important since all individuals were Medicare beneficiaries, although we could not account for potential differences in copayments and deductibles. We also adjusted for population density to account for the possibility that rural outcomes may be worse because of weaker health care infrastructure in

these areas, although we actually found higher CRC incidence and mortality in areas with high population density. However, because urban beneficiaries comprised 84% of the study population, including 39% of the least densely populated quartile and the vast majority of the more densely populated quartiles, the population density variable best reflects differences between urban areas. Our findings suggest that rural and densely populated urban areas both suffer from poorer CRC outcomes for different reasons. These results are consistent with previous state-level studies that found late-stage disease was more likely in areas at either end of the urban-rural spectrum.^{23,24} Given the implication for resource allocation for CRC prevention and treatment, further research is needed to better understand this relationship.

Individuals living in areas with the highest supply of specialists per capita had lower CRC incidence and mortality during the early investigative period, whereas there was no durable association between PCP supply and outcomes. We used PCSA-level specialist physician supply as a measure of access to specialists involved in the diagnosis and treatment of CRC. Previously, Gorey and associates found no association between gastroenterologist supply and either early stage disease or survival for cases diagnosed in California prior to Medicare coverage for screening colonoscopy in 2001.²⁵ Ananthakrishnan and colleagues found that gastroenterologist supply was inversely correlated with late-stage disease in Pennsylvania, but only after 2001 and only in non-metropolitan or low population density counties.²⁶ Similarly, a Texas study found that access to oncologists was only associated with improved survival in non-urban areas.¹⁷ These 3 studies all used state-level cancer registries and included both Medicare and non-Medicare patients. Our analysis of all specialists across the urban-rural spectrum suggests they played a significant role in CRC prevention before the era of widespread colonoscopic screening, which may be attributed to the preventive effect of endoscopy performed by gastroenterologists and surgeons for indications unrelated to screening. After Medicare covered screening sigmoidoscopy and then colonoscopy, areas with fewer specialists may have seen a greater increase in endoscopy than areas with more specialists and higher baseline procedural volume, thereby decreasing the disparity in specialist supply. Indeed, while the median specialist supply was unchanged in urban and large rural areas from the 2000 to 2010 Census, the median specialist supply increased by 45% in small rural areas over this period (Table 2). Unfortunately, we were unable to examine the association with specific specialties because these data were not available at the PCSA level.

In 1973–1997, prior to Medicare screening reimbursement, areas with high PCP supply had a slightly lower odds of CRC incidence. The rise in incidence ORs for PCP supply from 1973–1997 to 1998–2001 may be related to Medicare coverage of FOBT and sigmoidoscopy after 1998 and increased CRC awareness after Katie Couric’s televised colonoscopy in 2000.²⁷ Although there was not a statistically significant association between PCP supply and CRC incidence in subsequent periods, we detected a small but still significant trend toward high PCP supply becoming protective against CRC incidence after 1998. This contrasts with the trend of high specialist supply becoming less protective over time, which may suggest the increasing relative importance of PCPs in CRC prevention. Several studies have reported a protective effect of primary care on CRC. Roetzheim and associates found that increasing PCP supply was associated with both early detection of CRC²⁸ as well as

reduced incidence and mortality using the Florida state cancer registry between 1993 and 1995.²⁹ A recent SEER-Medicare study by Ferrante and colleagues found that greater primary care utilization was associated with lower CRC incidence and mortality, and the relationship was stronger after Medicare coverage for colonoscopy.³⁰ Our incidence results from the earliest investigated period are consistent with findings from the Florida study. The discrepancy between our findings and those of Ferrante and colleagues in later periods may reflect our use of PCP supply as an imperfect surrogate measure of primary care utilization. In addition, ecological bias and adjustment for multiple geographic variables in our model may have resulted in weaker associations than in previously reported studies, though it is not possible to generalize the direction of change for ecological associations when compared to individual associations.³¹ However, the trend we observed for PCP supply can only be considered suggestive, and either longer follow up or a better measure of primary care utilization is needed for a more definitive analysis.

Racial disparities in CRC screening, treatment, and mortality are well-documented among blacks. Doubeni and associates found screening among Medicare beneficiaries was lower among blacks than whites both before and after coverage for colonoscopy.⁶ Other studies using the SEER database have shown that blacks who are diagnosed with CRC are less likely to receive surgery,³² and those who undergo surgery have higher 5-year mortality than whites.³³ Modeling data estimates that differences in screening accounted for 42% of the disparity in incidence and 19% of the disparity in mortality between blacks and whites.³⁴ Our results support and extend findings from these previous studies, showing that disparities in CRC incidence and mortality between blacks and whites have worsened over time, even after adjusting for geographic and socioeconomic factors. Although absolute CRC incidence and mortality rates have decreased in all racial/ethnic groups since the 1990s,³⁵ blacks continue to have the highest rates. Hispanics and Asians have the lowest CRC screening rates in the US but also have the lowest incidence and mortality rates.³⁵ This discrepancy may be explained by a favorable combination of biologic, dietary, and cultural factors. Our study shows that while Hispanics and Asians continue to have lower CRC mortality relative to whites, this advantage was attenuated after and likely because of Medicare coverage for screening. Gomez and colleagues previously reported higher CRC mortality for Hispanic men compared to whites for cases diagnosed between 1992–1996 and followed through 1999 in SEER-Medicare.¹⁰ We replicated these results but found that Hispanic ethnicity became protective against mortality after extending the length of follow up. The reason for this finding is unclear, and we did not find a similar reversal of the direction of association for blacks or Asians. Additional research is needed to investigate factors that may promote long-term survival, specifically among Hispanics.

Areas with higher socioeconomic status have historically had increased rates of CRC mortality in both Medicare and non-Medicare populations,¹¹ but after 1998 an inverse relationship between socioeconomic status and mortality across racial/ethnic groups has been reported.^{12,13} We separately analyzed 2 components of socioeconomic status—education level and median household income—and found that the reversal in the trend for CRC incidence and mortality occurred at different times. Higher income and education level became protective against mortality after 1998 and 2002, respectively, suggesting that income may be an earlier or more important harbinger of socioeconomic associations with

CRC than education. The recent trend can be explained by Link and Phelan's fundamental causes theory, which postulates that innovations in disease prevention and treatment are not equally accessible to all and leads to health disparities favoring the socioeconomically advantaged.^{36,37} Our finding that the trend reversals for mortality occurred earlier than for incidence suggests socioeconomically advantaged groups benefited first from advances in treatment and then from greater access to screening.

Strengths and Limitations

Our study has several strengths. First, we analyzed nearly 4 decades of data from a nationally representative sample of Medicare beneficiaries and included both individuals with non-CRC cancers and those without cancer as controls, all of which enhanced the generalizability of our findings. Second, we used PCSA-level contextual data to capture the smallest geographic areas where individuals receive care, thereby partially mitigating the risk of ecological fallacy seen with studies conducted at the county or state level. Third, we selected time periods of analysis based on relevant Medicare reimbursement changes, which improved the interpretability of the temporal trends.

We also acknowledge several limitations. First, we only included individuals older than 65 in our analysis and therefore these results may not be generalizable to younger individuals. However, individuals older than 65 comprise 61% of incident cases and 71% of CRC deaths,³⁵ making them the most relevant population segment to study. Second, because contextual data were only available from the 2000 and 2010 Census, we may not have accounted for more subtle geographic and sociodemographic changes. Nevertheless, we would expect this to bias the results toward the null and therefore underestimate the magnitude of the associations we reported. Third, we used specialist supply as a measure of access to specialists involved in the diagnosis and care of CRC, but specific data on gastroenterologists, surgeons, and oncologists were not available at the PCSA level. We would expect that the inclusion of specialists who are not involved in CRC would also bias the results toward null and underestimate the strength of the associations we observed. Fourth, given the large sample size there is a risk of finding statistically significant differences that have limited clinical or policy relevance, and the risk is especially high with isolated associations. The context provided by temporal trends mitigates this problem, but ultimately the interpretation of significance remains a subjective process. Finally, while the temporal trends suggest a population-level relationship between evolving policy changes in CRC screening and outcomes, this relationship remains speculative without individual-level data, and we acknowledge that other factors may be involved. An analysis of whether receipt and type of screening affects CRC incidence and mortality would be invaluable, but the aim of this study was to characterize population-level trends and identify groups who may benefit from targeted intervention.

Conclusion

In summary, individuals who are rural residents, black, and have lower socioeconomic status are more likely to be diagnosed with and die from CRC. Rural inequalities have persisted for 4 decades, whereas racial and socioeconomic disparities have in fact worsened over time.

Targeted interventions to improve screening in these high-risk groups are needed to reduce the outcome disparities for this preventable disease.

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Table 1

Population Characteristics

Variable	All Patients	Cases	Controls	All Patients, by Time Period			
	All Years	All Years	All Years	1973–1997	1998–2001	2002–2006	2007–2010
Sociodemographic Factors							
Median age (IQR)	75 (68–82)	79 (73–85)	72 (67–81)	76 (71–83)	75 (68–82)	75 (68–82)	70 (67–80)
Females, %	56.0	52.2	57.7	57.5	56.7	55.7	53.8
Race/ethnicity, %							
White	81.9	83.0	81.5	82.9	82.5	81.6	80.5
Black	7.9	8.3	7.7	7.3	7.9	8.1	8.3
Asian	4.3	3.8	4.5	3.7	4.1	4.5	4.8
Hispanic	2.3	1.6	2.6	2.1	2.3	2.4	2.4
Other	3.7	3.4	3.8	4.1	3.3	3.4	4.1
Population with 12 yrs education, median % (IQR) ^a	57.5 (50.2–61.9)	57.9 (51.2–62.3)	57.2 (49.9–61.8)	54.6 (48.1–59.3)	53.9 (46.7–59.1)	56.9 (49.5–61.8)	57.0 (49.7–61.8)
Household income in USD, median (IQR) ^a	60,009 (47,013–74,253)	60,362 (47,285–74,448)	59,938 (47,013–74,193)	46,997 (38,541–57,245)	46,501 (37,629–57,064)	59,620 (46,792–74,006)	60,387 (47,364–74,669)
Geographic Factors							
Rural/urban, % ^a							
Urban	84.4	84.7	84.2	85.4	84.4	83.7	84.1
Rural, large	7.6	7.1	7.8	6.8	7.6	8.1	7.9
Rural, small	8.0	8.2	8.0	7.8	8.0	8.3	8.0
Population density per square mile, median (IQR) ^a	1,351 (228–3,456)	1,542 (256–4,206)	1,219 (210–3,367)	1,414 (286–3844)	1,102 (244–3,347)	1,148 (197–3,200)	1,140 (204–3,175)
Population with 1 hr travel time to work, median % (IQR) ^a	3.2 (2.0–4.8)	3.2 (2.0–4.7)	3.2 (2.0–4.8)	3.2 (2.1–4.7)	3.2 (2.2–4.9)	3.2 (2.0–4.8)	3.2 (2.0–4.9)
Specialist per 100,000 people, median (IQR) ^a	112 (60–187)	115 (60–187)	111 (60–185)	116 (72–192)	109 (66–175)	109 (58–184)	108 (58–182)
PCPs per 100,000 people, median (IQR) ^a	70 (51–100)	71 (52–104)	70 (51–97)	72 (54–98)	69 (53–94)	69 (50–95)	69 (50–95)
Sample Size							
CRC cases	336,321	336,321	–	87,435	72,628	112,892	63,366
CRC deaths ^b	103,813	103,813	–	29191	24,236	35,546	14,840
Controls	757,437	–	757,437	196,948	163,542	254,289	142,658

Variable	All Patients	Cases	Controls	All Patients, by Time Period		
Sociodemographic Factors	All Years	All Years	All Years	1973–1997	1998–2001	2002–2006
Total n	1,093,758	336,321	757,437	284,383	236,170	367,181
						206,024

Abbreviations: CRC, colorectal cancer; IQR, interquartile range

^aData provided at the primary care service area (PCSA) level. For 1973–1997 and 1998–2001 analyses, data from the 2000 Census were used. All other analyses used 2010 Census data.

^bTime periods indicate year of diagnosis, not year of death

Table 2**Urban vs Rural Population Characteristics**

Variable	Urban		Large Rural		Small Rural	
Number of beneficiaries (%)	914,856 (84.4)		82,387 (7.6)		87,142 (8.0)	
<u>Sociodemographic Factors</u>						
Median age (IQR)	75 (68–82)		74 (68–82)		75 (68–82)	
Females, %	56.1		55.9		55.5	
Race/ethnicity, %						
White	80.6		86.7		91.8	
Black	8.3		5.7		5.2	
Asian	4.8		2.1		0.5	
Hispanic	2.4		1.9		0.7	
Other	3.8		3.6		1.9	
<u>Geographic Factors</u>	<u>2000 Census</u>	<u>2010 Census</u>	<u>2000 Census</u>	<u>2010 Census</u>	<u>2000 Census</u>	<u>2010 Census</u>
Population with 12 yrs education, median % (IQR) ^a	54.2 (47.6–59.6)	57.7 (51.0–62.0)	50.2 (43.9–55.8)	53.5 (47.9–60.2)	51.7 (43.0–57.4)	56.7 (49.2–62.3)
Household income in USD, median (IQR) ^a	48,910 (40,923–60,083)	63,552 (51,557–77,468)	34,827 (30,286–39,654)	43,592 (38,059–50,128)	33,277 (28,516–37,392)	41,653 (34,670–46,816)
Population density per square mile, median (IQR) ^a	1,721 (521–3,940)	1,873 (561–4,638)	87 (54–126)	77 (45–132)	37 (22–58)	34 (20–58)
Population with 1 hr travel time to work, median % (IQR) ^a	3.4 (2.2–5.3)	3.4 (2.0–4.9)	2.4 (1.8–3.5)	2.2 (1.7–3.3)	2.8 (1.9–4.0)	2.6 (1.7–3.7)
Specialists per 100,000 people, median (IQR) ^a	119 (79–200)	119 (70–205)	76 (41–116)	77 (47–109)	22 (6–48)	32 (12–61)
PCPs per 100,000 people, median (IQR) ^a	71 (55–98)	72 (54–106)	59 (50–76)	59 (45–74)	54 (39–77)	53 (34–72)

Abbreviations: IQR, interquartile range

^aData provided at the primary care service area (PCSA) level.

Table 3

Factors Associated With Colorectal Cancer Incidence by Year of Diagnosis

Variable ^a	Adjusted Odds Ratio ^b (95% CI)			
	1973–97 (n=275,135)	1998–2001 (n=228,195)	2002–06 (n=364,154)	2007–10 (n=204,179)
<u>Sociodemographic</u>				
Age, per year	1.04 (1.04–1.05)	1.05 (1.05–1.05)	1.07 (1.07–1.07)	1.12 (1.12–1.12)
Sex, female	0.65 (0.64–0.66)	0.71 (0.70–0.73)	0.73 (0.71–0.74)	0.74 (0.72–0.75)
Race/ethnicity				
Black	1.09 (1.05–1.13)	1.09 (1.05–1.13)	1.17 (1.14–1.21)	1.32 (1.27–1.37)
Asian	0.88 (0.84–0.92)	0.86 (0.82–0.90)	0.78 (0.75–0.80)	0.82 (0.78–0.87)
Hispanic	0.64 (0.59–0.68)	0.60 (0.56–0.65)	0.63 (0.60–0.67)	0.59 (0.55–0.64)
Education ^c	1.54 (1.48–1.59)	1.14 (1.10–1.18)	1.04 (1.01–1.07)	0.97 (0.93–1.00)
Median household income ^c	1.32 (1.27–1.38)	1.00 (0.96–1.04)	0.94 (0.91–0.96)	0.90 (0.86–0.94)
<u>Geographic</u>				
Rural/urban ^c				
Rural, large	1.20 (1.15–1.25)	1.07 (1.02–1.11)	1.06 (1.03–1.10)	1.07 (1.02–1.12)
Rural, small	1.50 (1.43–1.57)	1.17 (1.11–1.22)	1.10 (1.06–1.14)	1.09 (1.04–1.15)
Population density ^c	2.09 (2.01–2.17)	1.42 (1.37–1.48)	1.18 (1.15–1.21)	1.14 (1.09–1.19)
Travel time to work ^c	0.74 (0.72–0.76)	0.95 (0.92–0.98)	1.10 (1.07–1.12)	1.13 (1.09–1.17)
Specialist supply ^c	0.88 (0.85–0.91)	0.94 (0.90–0.98)	0.97 (0.93–1.00)	0.97 (0.92–1.02)
PCP supply ^c	0.94 (0.90–0.97)	1.01 (0.97–1.06)	0.99 (0.96–1.03)	0.96 (0.92–1.01)

^a Age is a continuous variable; Sex: male is reference; Race: white is reference; Rural/urban: urban is reference; all other variables: OR shown for highest quartile of Primary Care Service Areas, with lowest quartile as reference

^b Adjusted for all other variables shown in the first column

^c Variables pertain to primary care service areas (PCSAs), not individuals

Table 4

Factors Associated With Colorectal Cancer Mortality by Year of Diagnosis

Variable ^a	Adjusted Odds Ratio ^b (95% CI)			
	1973–97 (n=275,135)	1998–2001 (n=228,195)	2002–06 (n=364,154)	2007–10 (n=204,179)
<u>Sociodemographic</u>				
Age, per year	1.02 (1.02–1.03)	1.05 (1.04–1.05)	1.06 (1.06–1.06)	1.10 (1.10–1.10)
Sex, female	0.80 (0.78–0.82)	0.79 (0.77–0.81)	0.82 (0.80–0.84)	0.87 (0.84–0.91)
Race/ethnicity				
Black	1.22 (1.16–1.28)	1.28 (1.21–1.34)	1.31 (1.26–1.36)	1.34 (1.26–1.42)
Asian	0.60 (0.55–0.65)	0.78 (0.72–0.84)	0.76 (0.72–0.81)	0.75 (0.69–0.83)
Hispanic	0.57 (0.51–0.64)	0.73 (0.65–0.81)	0.72 (0.66–0.78)	0.68 (0.60–0.77)
Education ^c	1.29 (1.22–1.36)	1.07 (1.02–1.14)	0.96 (0.93–1.00)	0.92 (0.87–0.98)
Median household income ^c	1.16 (1.09–1.23)	0.95 (0.90–1.01)	0.91 (0.87–0.96)	0.82 (0.77–0.88)
<u>Geographic</u>				
Rural/urban ^c				
Rural, large	1.07 (1.00–1.15)	1.03 (0.97–1.11)	1.07 (1.01–1.12)	1.04 (0.96–1.12)
Rural, small	1.35 (1.26–1.45)	1.09 (1.01–1.16)	1.12 (1.06–1.18)	1.10 (1.01–1.20)
Population density ^c	1.71 (1.61–1.81)	1.27 (1.20–1.34)	1.15 (1.10–1.20)	1.12 (1.04–1.20)
Travel time to work ^c	0.82 (0.78–0.85)	0.98 (0.94–1.03)	1.11 (1.07–1.15)	1.04 (0.99–1.10)
Specialist supply ^c	0.84 (0.79–0.89)	0.93 (0.87–0.99)	0.93 (0.88–0.98)	0.92 (0.85–1.00)
PCP supply ^c	1.00 (0.95–1.06)	1.03 (0.97–1.10)	1.04 (0.99–1.10)	1.00 (0.92–1.08)

^a Age is a continuous variable; Sex: male is reference; Race: white is reference; Rural/urban: urban is reference; all other variables: OR shown for highest quartile of Primary Care Service Areas, with lowest quartile as reference

^b Adjusted for all other variables shown in the first column

^c Variables pertain to primary care service areas (PCSAs), not individuals