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Association of Local Capacity for Endoscopy with Individual Use of Colorectal Cancer Screening and Stage at Diagnosis

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Abstract

Background—Limited capacity for endoscopy in areas where African-Americans and Hispanics live may be a reason for persistent disparities in colorectal cancer (CRC) screening and stage at diagnosis.

Methods—We linked data from the National Health Interview Survey (NHIS) on the use of CRC screening and data from SEER-Medicare on CRC stage with measures of county capacity for colonoscopy and sigmoidoscopy (“endoscopy”) derived from Medicare claims.

Results—Hispanics lived in counties with less capacity for endoscopy than African-Americans or whites (for NHIS, an average of 1,224, 1,569, and 1,628 procedures per 100,000 individuals age 50 and above respectively). Individual use of CRC screening increased modestly as county capacity increased. For example, as the number of endoscopies per 100,000 residents increased by 750, the odds of being screened increased by 4%. Disparities in screening were mitigated or diminished by adjustment for area endoscopy capacity, racial/ethnic composition, and socioeconomic status. Similarly, among individuals with CRC, those who lived in counties with less endoscopy capacity were marginally less likely to be diagnosed at an early stage. Adjustment for area characteristics diminished disparities in stage for Hispanics compared to whites but not African-Americans.

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Conclusions—Increasing the use of CRC screening may require interventions to improve capacity for endoscopy in some areas. The characteristics of the area where an individual resides may in part mediate disparities in CRC screening use for both African-Americans and Hispanics, and disparities in cancer stage for Hispanics.

Keywords

colorectal cancer; screening; disparities; regional variation

Introduction

Colorectal cancer (CRC) is the third most commonly diagnosed cancer in the United States (US).¹ Screening for CRC is firmly established to reduce CRC mortality, both by decreasing incidence and by detecting cancers at an earlier, more treatable stage.² It is therefore widely endorsed by professional societies and expert panels for average-risk adults over the age of 50 years.^{3–7} Although there are several established options for CRC screening for average-risk persons age 50 and above, including fecal occult blood testing (FOBT), sigmoidoscopy and colonoscopy, CRC screening is underused,^{1, 8–10} and there is significant area-level variation in CRC screening.¹¹ There are also important disparities in CRC screening by race/ ethnicity. Studies have consistently shown that African-Americans and Hispanics are less likely than whites to use CRC screening.^{12–19} Population-based studies have also demonstrated that African-Americans present with later stage CRC than whites, in part because of disparities in the use of CRC screening.²⁰

Colonoscopy is an increasingly important screening modality because it can be used to screen for, as well as remove, suspicious lesions, examines the entire colon, and is required as follow-up after all positive FOBT's. In recognition of this importance, Medicare has covered screening colonoscopy for average-risk adults since 2001 (previously Medicare reimbursement was limited to FOBT and sigmoidoscopy for these beneficiaries). This change in coverage has led to a modest increase in the use of colonoscopy,^{21–23} although coverage has not reduced disparities in use by race/ ethnicity.^{14, 23, 24} While there are several potential reasons that disparities have not diminished with this important policy change, one possibility is more limited capacity for colonoscopy in areas where African-Americans and Hispanics live.

The objective of our analysis was to examine whether capacity for CRC screening in an area where an individual resides is associated with use of CRC screening and stage at diagnosis; and whether racial/ ethnic disparities in the use of CRC screening and stage at diagnosis are reduced by controlling for the capacity of CRC screening and the sociodemographic characteristics of the area where an individual resides.

Methods

Data Sources

These analyses utilized several data sources: (1) the 2000 and 2003 National Health Interview Surveys (NHIS) were used to examine utilization of CRC screening; (2) the Surveillance, Epidemiology and End Results (SEER)-Medicare File, for cancers diagnosed 1998–2002, was used for analyses of stage at diagnosis; (3) Medicare claims data, specifically the 2000 National Claims History (NCH or Carrier File), and Outpatient File, collected by Centers for Medicare and Medicaid Services (CMS) were used to create a measure of county CRC capacity; and (4) the Area Resource File (ARF) was used to create measures of county primary care physician (PCP) capacity, racial/ ethnic composition and

socio-economic status (SES). This study was reviewed and approved by the Institutional Review Board of Partners HealthCare.

NHIS, conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention (CDC), was used for the analyses of CRC screening use. NHIS is a nationally representative household survey that collects information about demographic characteristics, chronic health conditions, health insurance, and health behaviors from the civilian, non-institutionalized U.S. population (www.cdc.gov/nchs/nhis.htm). In 2000 and 2003, the NHIS included a Cancer Control Supplement, which asked respondents about the use of CRC screening.²⁵ Because these analyses required merging NHIS with the area-level variables described below, all analyses were conducted through the Research Data Center of the National Center for Health Statistics.

SEER-Medicare data were used for analyses of stage at diagnosis. The SEER program collects information on all incident cancer cases for persons with cancer residing in SEER program areas (California, Connecticut, Hawaii, Iowa, Kentucky, Louisiana, New Jersey, New Mexico and Utah, rural Georgia, and the metropolitan areas of Detroit, Atlanta, and Seattle).²⁶ SEER data include primary tumor site, stage at diagnosis, based on the modified American Joint Committee on Cancer (AJCC) staging system, and patient demographics and are linked to Medicare claims data by the National Cancer Institute. A restricted access version of these data was obtained so that the area-level characteristics could be appended.

Medicare claims, specifically the Carrier and Outpatient Files, for persons who had a screening sigmoidoscopy or colonoscopy were used to create aggregate measures of CRC screening capacity in the county where an individual resided. Data from the ARF was used to create a year 2000 county-level measure of PCP capacity and measures of area racial/ethnic composition and SES. The ARF includes the number of physicians by specialty type and work setting in each county, the population by age in each county, the percentage of each county that is African-American and Hispanic and the median income for each county.

Study Subjects

For the analyses of screening utilization, we used the NHIS data and included adults age 50 and older, who had not previously been diagnosed with colorectal cancer, whose race/ethnicity was reported as white, African-American or Hispanic, and who responded to questions regarding the use of CRC screening (n=23,229).

For the analyses of cancer stage, we used the SEER-Medicare data and included adults age 65 to 95, whose race/ethnicity was reported as white, black or Hispanic and who were diagnosed with modified AJCC Stage I, II, III or IV CRC as a single primary from 1998 to 2002 (n= 52,317).

Variables

Individual Variables—In both the NHIS and SEER-Medicare samples, individual level variables included sex, age (10-year intervals), race/ ethnicity (white, African-American, Hispanic), marital status (married or living with a partner vs. other) and comorbidity. Comorbidity was measured slightly differently in the two datasets because of different data availability. In the NHIS dataset, participants were asked to endorse a variety of chronic conditions (e.g., arthritis, peptic ulcer disease, chronic lung disease). These were counted and categorized as 0, 1, 2, ≥ 3). For SEER-Medicare, claims data were used to calculate the modified Charlson comorbidity index (also categorized as 0, 1, 2, ≥ 3).²⁷

Additional individual variables available in the NHIS included education (grade school or middle school, high school graduate or vocational school, some college, college graduate),

prior history of cancer other than CRC, and health insurance (uninsured, Medicare with private supplemental insurance or private insurance, Medicare without supplemental coverage, and Medicaid or dual eligibility for Medicare and Medicaid). We also included health-care-seeking behavior, defined as having a usual source of care, evidenced by a visit to any health care professional in the past year, and the number of behavioral risk factors for CRC, including current cigarette use, heavy drinking (consuming 60 or more alcoholic drinks per month for men and 30 or more for women), and lack of regular exercise.^{28, 29}

Additional individual-level independent variables in the SEER-Medicare dataset included whether an individual was of “low income” (based on eligibility for state assistance with Medicare premiums and co-payments), cancer type (colon, rectal), year of diagnosis, and an indicator of whether someone had non-continuous Medicare coverage or was in an HMO in the 13 months prior to diagnosis, in order to adjust for potentially incomplete data about chronic conditions for these individuals.

Area Variables

CRC Screening Capacity: To create a measure of regional capacity for CRC screening, we first selected records from the 2000 Carrier and Outpatient Files that included a bill for screening sigmoidoscopy (Health Care Common Procedure Coding System (HCCPS): G0104, or Current Procedural Terminology (CPT) codes: 45305, 45308, 45309, 45315, 45320, 45331) or screening colonoscopy (HCCPS: G0105, G0121; CPT: 45380, 45384, 45385).³⁰ There were a total of 1,198,597 unique Carrier and Outpatient records (multiple records actually make up a claim) based on patient identifier, procedure code and date of procedure for the 50 United States. Claims for the same procedure within 7 days were considered to be duplicates for the same procedures and the duplicate claim was deleted (n=8,976). Next, we identified the performing physician and zip code from the Carrier File, or the facility and county from the Outpatient File. Carrier Files with missing zip codes or with incorrect zip codes and Outpatient Files without county were deleted (n = 2,757), for a total of 1,186,864 records. Physicians who performed a colonoscopy or sigmoidoscopy were assigned to a county using zip code. If a zip code crossed county lines, it was assigned to the county with the greatest percentage of its population. Approximately 85% of zip codes were wholly contained within one county. Finally, we tabulated the number of sigmoidoscopies and colonoscopies performed in each county. We defined the screening capacity of the county as the number of colonoscopies and sigmoidoscopies performed in the county, per 100,000 residents age 50 and older. This measure was merged to the SEER and NHIS datasets by county.

PCP Capacity: Because PCPs are typically a gateway to CRC screening, we used data from the ARF for the number of PCPs in each county, defined as office-based physicians practicing the specialties of general practice, family practice, general internal medicine, or obstetrics/gynecology.³¹ We then calculated the number of PCPs per 100,000 residents age 50 and above for each county as our measure of PCP capacity. This measure was merged to the SEER and NHIS datasets by county. There were 844 counties included in the NHIS sample and 463 in the SEER-Medicare sample.

Racial/ ethnic Composition and SES: For NHIS, we used data from the ARF for the county racial/ethnic composition, defined as the percentage of the county that was African-American and Hispanic, and county SES, measured by median household income. The same measures were used, but at the census tract level, for the SEER-Medicare data.

Outcome Variables

Use of CRC Screening—Respondents to the NHIS were asked several questions about their use of CRC screening. Our measure for the use of CRC screening was whether an individual reported that they had ever been screened for CRC, using FOBT, sigmoidoscopy or colonoscopy. In a secondary analysis, we also examined whether an individual's CRC screening had been done with either a sigmoidoscopy or colonoscopy.

Stage at Diagnosis—Stage at diagnosis was defined using the AJCC classification method that is available in the SEER-Medicare data (categorized as stage I, II, III or IV).

Data Analysis

We used bivariate analyses to examine the associations of an individual's race/ethnicity with demographic, area and outcome variables; chi-square tests and univariate linear regression models were used to determine statistical significance. To examine the effect of CRC screening capacity in an individual's county of residence on individual screening, we constructed multi-level logistic regression models that accounted for clustering of individuals in the counties. To examine the effect of CRC screening capacity on stage at diagnosis, we constructed ordinal logistic regression models, clustered by county. In both sets of models, we included independent variables that we believed, *a priori*, could potentially affect the outcomes, based on our prior work and previous studies in the literature. The analyses of the NHIS also accounted for the survey sample weights. All area-level variables were modeled for a change of approximately 1 standard deviation (increments of 750 procedures per 100,000 individuals for CRC capacity, increments of 100 PCPs per 100,000 individuals, increments of 5% for the measures of racial/ethnic composition, and increments of \$20,000 for median household income). We tested correlations between the capacity measures and area racial/ethnic composition, and we tested for non-linear associations of both capacity measures with the outcomes by including a squared term for each measure in the models; in the model of CRC screening these quadratic trends were statistically discernable because of the large sample size but had a small magnitude of effect (e.g., odds ratio of 0.99) so, for ease of interpretation, the final models report only the linear trend. All analyses were done using SAS version 9.1 (SAS Institute, Cary, NC).

In order to examine whether area CRC screening or PCP capacity mediated any racial/ethnicity disparities in screening or stage at diagnosis, we built a sequence of models. First, we constructed models that included only individual-level variables. Specifically, the first CRC screening model included individual variables of age, sex, race, educational attainment, marital status, previous history of cancer, chronic conditions, behavioral risk factors for CRC, health insurance, usual source of care and whether the subject had a dental visit in the past year, and the year of the NHIS survey. The first stage at diagnosis model included the individual-level variables of age, sex, race, marital status, colon or rectal cancer, chronic conditions, whether an individual had ever been eligible for state buy-in insurance, and whether the individual was an HMO member or did not have Medicare for the 13 months prior to diagnosis, and year of diagnosis. For both outcomes, a second set of models added the measures of county CRC screening capacity, PCP capacity, and measures of the area racial/ethnic and SES.

Results

Description of the Study Samples

Subjects in both samples were predominately white (Table 1). In order to take into account the recommended starting age for CRC screening for average risk individuals, the age range

was younger in the NHIS dataset (age 50 and older) than the SEER-Medicare dataset (age 65 and older). In both datasets, whites were older than African-Americans and Hispanics. In the NHIS dataset, whites were more likely to have graduated from college (24.0%), compared to African-Americans (13.7%) and Hispanics (9.2%). Educational attainment was not available in the SEER-Medicare dataset. In both samples, African-Americans had more comorbidity than whites and Hispanics. In the NHIS sample, Hispanics were most likely to be uninsured and were also least likely to have a usual place of care. Details of health insurance were not available in the SEER-Medicare data, although African-Americans and Hispanics were more likely to have eligibility for state buy-in coverage.

Whites were most likely (54.3%) and Hispanics least likely (33.4%) to have ever been screened for CRC by any method. Among those screened, African-Americans were less likely to have had a sigmoidoscopy or colonoscopy, than whites or Hispanics. Whites and Hispanics were more likely to be diagnosed with CRC at an earlier stage than African-Americans (e.g., 17.7% of Hispanics, 17.0% of whites and 24.5% of African-Americans were diagnosed at stage IV).

Description of the Characteristics Where Subjects Reside

In both the NHIS and SEER-Medicare samples, African-Americans and Hispanics lived in counties with a greater number of PCP's per 100,000 people than whites (Table 2). Conversely, Hispanics lived in counties with fewer CRC screening procedures per 100,000 people than either whites or African-Americans. African-Americans and Hispanics lived in areas where there were a higher percentage of individuals of the similar racial/ ethnic group. In both samples, African-Americans lived in areas with the lowest average household income and whites in areas with the highest. Measures of CRC screening capacity were not significantly correlated with measures of area race/ethnicity or SES.

Use of CRC Screening

Overall, individual use of CRC screening increased modestly as county screening capacity increased (Table 3). For example, as the number of colonoscopies and sigmoidoscopies per 100,000 residents in the county age 50 and above increased by 750, the odds of being screened increased by 4%. There was no association between PCP capacity and screening. In the secondary analyses, where we examined whether an individual had ever been screened using sigmoidoscopy or colonoscopy, as opposed to having been screened by FOBT only, we found that an individual's use of sigmoidoscopy or colonoscopy increased as county capacity for these procedures increased (OR 1.04, CI 1.02–1.07). PCP capacity was not associated with screening by sigmoidoscopy or colonoscopy. As the percentage of African-Americans or Hispanics in the county of residence increased, there was a modest decline in the use of CRC screening by the individuals who lived there. As the average household income of the county increased, use of screening increased.

African-Americans were less likely than whites to have ever been screened for CRC after adjustment for individual-level variables (odds ratio (OR) 0.87, 95% confidence interval (CI) 0.78–0.96). This disparity was mitigated by adjustment for area capacity for colonoscopy and sigmoidoscopy, capacity for PCPs, racial/ ethnic composition and SES (OR 0.93, CI 0.83–1.04). After adjustment for individual-level factors, Hispanics were also less likely than whites to be screened for CRC (0.68; 0.60–0.77). Although this disparity persisted, it was diminished 7% after accounting for differences in area characteristics.

Stage at Diagnosis

Among individuals with CRC, those who lived in counties with less CRC screening capacity were marginally less likely to be diagnosed at an early stage (OR 0.98, CI 0.97–1.00) (Table

4). Individuals with CRC who lived in counties with more PCPs were marginally more likely to be diagnosed at a later stage. As the household income of the area increased, diagnosis with late-stage CRC declined. There was no association between the racial/ ethnic composition of the area where an individual resided and stage at diagnosis.

After adjustment for individual-level factors, African-Americans were more likely to be diagnosed at a later stage of CRC than whites (odds ratio (OR) 1.38, 95% CI (CI) 1.30–1.46). This difference persisted, largely unchanged with adjustment for both area screening capacity and area demographic characteristics. After adjustment for individual factors, Hispanics were modestly more likely than whites to have a late stage diagnosis (OR 1.06, CI 1.00–1.13). However, further adjustment for area screening capacity and socioeconomic characteristics eliminated any differences between Hispanics and whites (OR 1.02, CI 0.94–1.10).

Discussion

These results suggest that individuals who live in counties with greater capacity for CRC screening are modestly more likely to receive screening and less likely to be diagnosed with late-stage CRC than individuals who live in counties with less capacity for CRC screening. There was no association between the capacity of PCPs and these outcomes. Adjustment for the characteristics of the area where an individual resides was associated with reduction of the racial/ ethnic disparities in CRC screening for both African-Americans and Hispanics compared to whites, and for late stage diagnosis of CRC for Hispanics compared to whites but not for African-Americans.

Prior work on the national level suggests that capacity for colonoscopy and sigmoidoscopy may limit the use of CRC screening,^{32, 33} and that there is substantial regional variation in the use of CRC screening.^{11, 30, 34} Studies of screening capacity in specific states demonstrate some variation in capacity for colonoscopy. A survey of endoscopy facilities in Montana found that capacity is adequate for current levels of screening but is not adequate to screen all eligible residents.³⁵ A survey of endoscopy sites in New Hampshire found that demand for screening colonoscopy was twice the available capacity in 2002.³⁶ Our work extends this literature by demonstrating that regional variation in CRC screening capacity is associated with regional variation in an individual's use of screening and stage at diagnosis. This finding is important because it suggests that improving the availability of colonoscopy and sigmoidoscopy in areas with low capacity may result in some improvements in the use of CRC screening and stage of diagnosis for CRC, particularly at the population level. Similar work, examining the role of physician supply on stage of diagnosis for breast cancer in Florida, found that overall physician supply was not associated with stage, but found a modest association between the supply of primary care physicians and early stage breast cancer diagnosis.³⁷

Prior work has also demonstrated substantial racial/ ethnic disparities in the use of CRC screening,^{10, 19, 38} that have persisted despite expanded coverage for colonoscopy by Medicare.¹⁷ Our results suggest that differences in the characteristics of the area where an individual resides may mediate some, but not all, of these disparities. The importance of the racial/ ethnic and sociodemographic characteristics of the area where one resides to the use of cancer-related care is supported by prior work.³⁹ This suggests that interventions designed to reduce disparities in the use of CRC screening or stage at diagnosis should consider not only improving local capacity for screening but also address other characteristics of the areas that may limit the dissemination of information about the importance of CRC screening.

This work has several potential limitations. Our measure of CRC screening capacity was constructed using claims data. Thus it reflects actual practice patterns, not potential capacity. Prior work suggests current demand for colonoscopy exceeds or approaches potential capacity,³⁶⁻⁴⁰ suggesting that our measure reflects capacity during the timeframe of this study. Use of colonoscopy in an area may be influenced by other factors beyond potential capacity of the providers, including the dissemination of information about the benefits of CRC screening. It is also possible that the lesser capacity for endoscopy may be in response to lesser demand, rather than the other way around, or that capacity is related to other factors such as regional variation in managed care market share which we did not assess. As our measure is derived from Medicare claims, it may underestimate total capacity, although prior work has shown strong correlation between measures based on Medicare claims alone compared to total utilization.⁴¹ Finally, we recognize potential biases inherent in the linkage of these various data sources, each defined by somewhat different time periods. Our estimate of the effect of CRC screening capacity on use of colonoscopy may therefore be conservative because migration of people into or out of geographic areas may decrease our ability to detect an association. A strength of this analysis is that we found consistent associations between endoscopy capacity and both use of screening and stage at diagnosis, measured in two different datasets.

Increasing the use of CRC screening may require interventions to improve capacity for colonoscopy and sigmoidoscopy in areas with lower utilization of these procedures. The characteristics of the area where an individual resides, including capacity for CRC screening, racial/ethnic composition and socioeconomic status, may in part mediate racial/ethnic disparities in CRC screening use for both African-Americans and Hispanics and disparities in late stage diagnosis for Hispanics.

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Table 1

Description of study samples by race/ ethnicity.

	NHIS ¹					SEER-Medicare			
	White	African-American	Hispanic	P-value	White	African-American	Hispanic	P-value	
N	17,666	2,926	2,637		44,964	4,148	3,204		
Overall %	83.3%	9.5%	7.2%		85.9%	7.9%	6.1%		
Age				<.0001				<.0001	
50–64	55.9%	62.0%	63.2%						
65–74	23.3%	21.9%	24.4%		39.9%	46.8%	51.1%		
75–85 ²	20.8%	16.1%	12.4%		46.5%	42.5%	38.9%		
86 and older					13.6%	10.7%	10.0%		
Sex				.0090				<.0001	
Female	54.0%	57.6%	54.0%		54.2%	59.5%	47.3%		
Education ³				<.0001					
Grade school or middle school	17.2%	36.3%	53.5%						
Completed high school or vocational school	34.0%	28.1%	22.0%						
Some college	24.9%	21.9%	15.2%						
College graduate	24.0%	13.7%	9.2%						
Chronic conditions				<.0001				<.0001	
None	30.2%	22.2%	34.7%		72.5%	68.1%	77.6%		
One	31.6%	30.3%	31.5%		16.6%	17.7%	12.9%		
Two	21.9%	25.8%	19.6%		5.8%	6.4%	4.5%		
Three or more	16.3%	21.7%	14.2%		5.1%	7.8%	5.0%		
Married ^{3,4}	68.6%	47.0%	65.9%	<.0001	52.9%	37.9%	55.7%	<.0001	
Insurance ³				<.0001					
No insurance	5.3%	9.6%	20.8%						
Medicare/ public insurance	4.5%	14.3%	18.5%						
Medicare only	10.4%	18.6%	17.1%						

	NHIS ¹				SEER-Medicare			
	White	African-American	Hispanic	P-value	White	African-American	Hispanic	P-value
Medicare/ private insurance	79.9%	57.5%	43.7%					
Ever eligible for state insurance buy-in					13.2%	34.7%	38.0%	<.0001
Usual source of care ³	95.5%	95.1%	87.5%	<.0001				
CRC Screening:								
Ever had CRC screening	54.3%	44.1%	33.4%	<.0001				
Among those screened, had colonoscopy/ sigmoidoscopy	68.0%	63.5%	67.8%	.0186				
Stage at diagnosis								<.0001
I					27.2%	21.9%	25.6%	
II					31.7%	29.0%	31.7%	
III					24.1%	24.5%	25.0%	
IV					17.0%	24.5%	17.7%	

¹ NHIS: weighted percentages.

² NHIS: age older than 85 included in 75–85 category.

³ Missing data for NHIS: education 254; marital status 78; insurance 77, usual source of care 359.

⁴ Missing data for SEER-Medicare: marital status 2145.

Table 2

Characteristics of Area of Residence

	NHIS				SEER-Medicare			
	White	African-American	Hispanic	P-value	White	African-American	Hispanic	P-value
Mean # of primary care physicians per 100K people ≥ 50 years (county)	205.8	214.4	221.2	<.0001	224.6	235.9	242.0	.0537
Mean # of colonoscopies & sigmoidoscopies per 100K people ≥ 50 years (county)	1627.9	1568.8	1224.2	<.0001	1412.3	1417.8	1053.5	<.0001
Mean % African-American [/]	10.1%	28.5%	11.7%	<.0001	6.0%	54.8%	6.0%	<.0001
Mean % Hispanic [/]	4.2%	5.4%	19.9%	<.0001	11.4%	15.0%	44.6%	<.0001
Mean household income [/]	\$ 43,081	\$ 40,914	\$ 41,330	<.0001	\$52,049	\$34,826	\$43,686	<.0001

[/] These measures are calculated at the level of the county for NHIS and at the level of the census tract for SEER-Medicare.

Table 3

Factors associated with Ever Being Screened for CRC, NHIS.

	Individual Characteristics ^I	Individual and Area Characteristics
	Odds Ratio (95% Confidence Interval)	
<u>Individual characteristics</u>		
Race/ethnicity		
White	Reference	Reference
African-American	0.87 (0.78–0.96)	0.93 (0.83–1.04)
Hispanic	0.68 (0.60–0.77)	0.73 (0.63–0.84)
Education		
Some high school	0.49 (0.43–0.55)	0.51 (0.45–0.57)
High school graduate	0.68 (0.62–0.75)	0.70 (0.63–0.77)
Some college	0.84 (0.76–0.92)	0.85 (0.77–0.94)
College graduate	Reference	Reference
Chronic conditions		
None	Reference	Reference
One	1.53 (1.41–1.65)	1.54 (1.42–1.66)
Two	1.97 (1.80–2.16)	2.0 (1.82–2.17)
Three or more	2.81 (2.55–3.11)	2.85 (2.58–3.15)
Health Insurance		
None	0.55 (0.48–0.63)	0.55 (0.48–0.64)
Medicaid alone or Medicare with public insurance	0.71 (0.62–0.80)	0.72 (0.63–0.81)
Medicare only	0.81 (0.73–0.91)	0.83 (0.74–0.93)
Medicare and private insurance	Reference	Reference
Usual source of medical care		
Yes	Reference	Reference
No	0.32 (0.26–0.38)	0.32 (0.26–0.38)
<u>County-level Capacity Measures</u>		
Number of primary care physicians per 100k population 50 and older (increments of 100)		1.02 (0.97–1.08)
Number of sigmoidoscopies or colonoscopies per 100k population 50 and older (increments of 750)		1.04 (1.01–1.06)
<u>County level racial composition/ SES</u>		
Percentage African-American (increments of 5%)		0.98 (0.97–1.00)
Percentage Hispanic (increments of 5%)		0.98 (0.96–1.00)
Median household income (increments of \$20,000)		1.14 (1.05–1.23)

All models also adjusted for age, sex, marital status, previous history of cancer, year of survey (2000 or 2003), risk factors for CRC (current cigarette use, heavy drinking, and lack of regular exercise), and having a dental visit in past year.

Table 4

Factors Associated with Later Stage Diagnosis of CRC, SEER-Medicare

	Individual Characteristics ^I	Individual and Area Characteristics
	Odds Ratio (95% Confidence Interval)	
Individual characteristics		
Race/ethnicity		
White	Reference	Reference
African-American	1.38 (1.30–1.46)	1.39 (1.28–1.50)
Hispanic	1.06 (1.0–1.13)	1.02 (0.94–1.10)
Ever eligible for state buy-in insurance		
Yes	1.02 (0.97–1.06)	1.00 (0.96–1.05)
No	Reference	Reference
Chronic conditions		
None	Reference	Reference
One	0.87 (0.83–0.90)	0.87 (0.83–0.91)
Two	0.86 (0.81–0.92)	0.86 (0.81–0.92)
Three or more	0.73 (0.68–0.78)	0.73 (0.68–0.78)
Cancer type		
Colon	1.39 (1.34–1.44)	1.39 (1.34–1.44)
Rectal	Reference	Reference
Number of primary care physicians per 100k population 50 and older (increments of 100)		1.02 (1.00–1.04)
Number of sigmoidoscopies /colonoscopies per 100k population 50 and older (increments of 750)		0.98 (0.97–1.0)
Percentage African-American (increments of 5%)		1.0 (0.99–1.00)
Percentage Hispanic (increments of 5%)		1.0 (1.00–1.01)
Median household income (increments of \$20,000)		0.98 (0.97–0.99)

Ordinal logistic regression model (stage 1 is the reference). Model also adjusted for age, sex, marital status, HMO or no Medicare in 13 months prior to diagnosis.