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RESEARCH ARTICLE

Colonoscopist and Primary Care Physician Supply and Disparities in Colorectal Cancer Screening

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Objective. To determine whether racial/ethnic disparities in colonoscopy use vary by physician availability.

Data Source. We used 100 percent Texas Medicare claims data for 2003–2007.

Study Design. We identified beneficiaries aged 66–79 in 2007, examined racial/ethnic differences in colonoscopy use from 2003 to 2007, and estimated the percentage of white, black, and Hispanic beneficiaries who underwent colonoscopy by level of physician availability and area income.

Principal Findings. For the 974,879 beneficiaries, colonoscopy use was higher in whites (40.7 percent) compared to blacks (35.0 percent) and Hispanics (28.7 percent, $p < .001$). For whites, increasing availability of colonoscopists and primary care physicians (PCPs) was associated with higher colonoscopy use. For blacks and Hispanics, colonoscopy use was unchanged or decreased with increases in colonoscopist and PCP availability. In multilevel models, the odds of colonoscopy were 20 percent lower for blacks (OR 0.80, 95 percent CI 0.79–0.82) and 32 percent lower for Hispanics (OR 0.68, 95 percent CI 0.66–0.69) compared to whites; adjusting for availability of colonoscopists or PCPs did not attenuate racial/ethnic disparities. We found greater racial/ethnic disparities in areas with greater colonoscopist and PCP availability.

Conclusions. Greater area availability of colonoscopists and PCPs is associated with increased use of colonoscopy in whites but decreased use in minorities, resulting in larger racial/ethnic disparities.

Key Words. Colorectal cancer, cancer screening tests, health care disparities, primary care physicians, colonoscopy

In 2010, there were an estimated 142,570 new cases and 51,370 deaths from colorectal cancer, making it the third leading cause of cancer-related deaths in men and women in the United States (Jemal et al. 2010). Blacks have higher incidence and death rates when compared to whites and other racial/ethnic minorities (National Cancer Institute 2006; Jemal et al. 2010).

Routine screening can provide early detection and improved survival for colorectal cancers (Selby et al. 1992; Hardcastle et al. 1996; Kronborg et al. 1996; Mandel et al. 1999, 2000). In March 2008, the American Cancer Society, the U.S. Multi-Society Task Force on Colorectal Cancer, and the American College of Radiology (Levin et al. 2008) jointly recommended screening for colorectal cancer beginning at 50 years of age by (1) high-sensitivity fecal occult blood test (FOBT) or fecal immunochemical testing annually, (2) flexible sigmoidoscopy every 5 years, (3) double-contrast barium enema every 5 years, (4) CT colonography (virtual colonoscopy) every 5 years, (5) colonoscopy every 10 years, or (6) fecal DNA at an unspecified interval. The report stated that approaches offering visualization of the colon were preferred to indirect methods.

According to the National Cancer Institute, approximately 1.6 million screening colonoscopies are performed annually (Brown, Klabunde, and Mysliwiec 2003). The increase in colorectal screening from <25 percent in the 1980s to 50–60 percent in 2006 can be attributed almost entirely to an increase in the use of screening colonoscopy (Holden et al. 2010). It is estimated that between 6 and 8 million colonoscopies would need to be performed every year to meet the steady-rate requirements for screening-eligible patients (Vijan et al. 2004).

There are racial disparities in colorectal cancer screening, with non-Hispanic whites being screened more frequently than blacks or Hispanics (Fenton et al. 2009; Maxwell and Crespi 2009; Doubeni et al. 2010). Lower screening rates among non-whites may be attributable to access to or characteristics of primary care physicians (PCPs; such as specialization, background, communication skills, or years into practice), geographic location, limited access to health care resources, reimbursement structures, population knowledge, cultural attitudes, health literacy, and socioeconomic disadvantage (O'Malley et al. 2005; Meissner et al. 2006; Levin et al. 2008).

Physician supply has been associated with increased use of screening tests in various cancers (Roetzheim et al. 1999; Campbell et al. 2003; Coughlin et al. 2008; Gorey et al. 2010). Although it has been shown that colorectal cancer screening is improved in patients who have a PCP (Brouse,

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Wolf, and Basch 2008), the effect of colonoscopist supply on overall colorectal cancer screening rates and screening with colonoscopy specifically is not fully understood. Several authors have suggested that colonoscopist supply might have an impact on the overall use of colonoscopy (Vijan et al. 2004; Meissner et al. 2006; Haas et al. 2010) and may increase (Meissner et al. 2006) or decrease (Haas et al. 2010) observed racial disparities in colonoscopy rates. Due to uniform coverage of colonoscopies in Medicare beneficiaries, and literature linking differences in access to health resources as a mechanism for racial/ethnic disparities (O'Malley et al. 2005; Meissner et al. 2006; Levin et al. 2008), we hypothesized that in this population an increase in colonoscopist supply would be associated with increased access to colonoscopies for whites, blacks, and Hispanics, which may be associated with changes in racial disparities.

The goal of our study was twofold. First, we examined the association between the availability of colonoscopists and PCPs and receipt of colonoscopy, done for any reason, in Medicare beneficiaries. Second, we described racial/ethnic differences in colonoscopy use and examined the interaction between availability of colonoscopists/PCPs and race/ethnicity in colonoscopy use. We hypothesized that (1) colonoscopy use overall and within racial/ethnic groups would be higher in areas with increasing supply of colonoscopists and PCPs, and (2) that black–white and Hispanic–white differences in colonoscopy use might diminish as the supply of colonoscopists and PCPs increases.

METHODS

Data Source

We used the claims and enrollment data for 100 percent of Medicare beneficiaries in Texas for the period 2002–2007. Patients' demographic and enrollment characteristics were obtained from the Denominator File. This file is used to determine beneficiary demographic characteristics, entitlement, and beneficiary participation in Medicare Managed Care Organizations, including beneficiary unique identifier, state and county codes, zip code, date of birth, date of death, sex, race, age, monthly entitlement indicators (Part A/B/Both), and reasons for entitlement. Age was the original reason for entitlement in 92.44 percent of beneficiaries while the remaining 7.56 percent were originally entitled due to disability or end-stage renal disease. In addition, we used the outpatient Standard Analytic File (SAF), which contains claims submitted by

institutional outpatient providers, and the Carrier SAF, which contains claims submitted by noninstitutional providers (physicians), to identify outpatient facility services and physician services. In addition, we obtained inpatient hospital admissions and claims data from the Medicare Provider Analysis and Review files. U.S. Census data for the year 2000 provided zip code-level income and population estimates.

Study Cohort

We selected Medicare beneficiaries aged 66–79 in the year 2007 ($n = 1,504,783$). From this cohort, we excluded beneficiaries who had an interruption in the continuous enrollment in parts A and B Medicare or who enrolled in a health maintenance organization (HMO) during the period 2002–2007 ($n = 509,378$). Finally, we excluded beneficiaries whose race was not white, black, or Hispanic ($n = 20,526$), yielding a final cohort of 974,879 beneficiaries.

Study Outcome

The study outcome was receipt of colonoscopy (for any reason) in the previous 5 years, including the year of cohort selection (2003–2007). Colonoscopies were identified by the following Current Procedural Terminology (CPT), Health care Common Procedure Coding System (HCPCS), and International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes (CPT: 44388, 44389, 44392, 44393, 44394, 45378, 45380, 45382, 45383, 45384, 45385; HCPCS: G0105, G0121; ICD-9-CM: 45.23, 45.25, 45.27, 45.41, 45.42, 45.43, 48.36). Beneficiaries with a Medicare claim for these codes during the study period were considered to have had a colonoscopy. Our study does not attempt to evaluate up-to-date screening colonoscopy rates. We evaluated overall colonoscopy use and included all procedures, whether their indication was for screening or for evaluation of any specific problem.

Physician Availability

Physician availability was defined as the number of physicians per 10,000 elders (65 years and older) in the Hospital Service Area (HSA). HSAs are local health care markets for hospital care. The Dartmouth Atlas research group defines HSAs by aggregating Medicare claims records at the zip

code level to determine service areas where a hospital or group of hospitals provides a preponderance of care (Wennberg et al. 2008). Physicians who provided services in more than one HSA were considered to be available in each. For HSAs that straddled the border between Texas and an adjoining state, we only counted patients and physicians who were in Texas zip codes.

We created two measures of physician availability: colonoscopist availability and PCP availability. Individual providers were differentiated according to their Unique Provider Identification Number or National Provider Identifier. A colonoscopist was defined as a physician who performed more than five colonoscopies per year, based on the 100 percent Texas Medicare claims data. We chose this cut-point in an attempt to exclude providers who appear in Medicare colonoscopy claims simply due to coding error or who only rarely performed the procedure. Colonoscopists were identified as gastroenterologists (GI colonoscopists) and non-GI colonoscopists, including surgeons, family practitioners and other specialists who performed 5 or more per year. Results were obtained using the overall colonoscopist availability as well as stratified by GI colonoscopists and non-GI colonoscopists, with similar results for both analyses. Since the results did not differ, we report the results for overall colonoscopist supply, not stratified by colonoscopist specialty. A PCP was defined as a general practitioner, family physician, general internist, or geriatrician based on Medicare specialty codes on Part B claims in the Medicare Carrier files. There were a total of 1,264 colonoscopists in Texas in 2003, and this number increased to 1,399 colonoscopists in 2007. For PCPs, the number increased from a total of 8,787 PCPs in Texas in 2003 to 9,306 PCPs in 2007.

Population size and physician counts in an HSA change from year to year. Therefore, physician availability for the study period was estimated using population estimates and physician counts for the years 2003 and 2007. Population estimates of the number of elders in the HSA in 2003 were obtained from the 2000 U.S. Census, and estimates of the number of elders in 2007 were obtained from 2006 population estimates from the Health Resources and Services Administration (<http://datawarehouse.hrsa.gov/pcsa2006.aspx>). We calculated physician availability in 2003 and in 2007 using the respective physician counts and population estimates for the HSA, weighted these availability estimates by the relative population size in the HSA for that year, and summed the weighted availability measures. Thus, physician availability in the HSA during the study period was defined by the following formula:

$$\begin{aligned} \text{Weighted physician availability} = & (\text{Physician availability in 2003} \\ & \times \text{weight 2003}) \\ & + \\ & (\text{Physician availability in 2007} \\ & \times \text{weight 2007}) \end{aligned}$$

where:

Weight 2003

$$= \frac{\text{Number of study cohort subjects residing in HSA in 2003}}{(\text{Number of study cohort subjects residing in the HSA in 2003} + \text{number residing in the HSA in 2007})}$$

Weight 2007

$$= \frac{\text{Number of study cohort subjects residing in HSA in 2007}}{(\text{Number of study cohort subjects residing in the HSA in 2003} + \text{number residing in the HSA in 2007})}$$

Measures of colonoscopist availability and PCP availability were stratified into quartiles for analysis.

Study Variables

We categorized beneficiaries by age, gender, and race/ethnicity using data from Medicare enrollment files. Age was categorized as 66–69, 70–73, 74–76, and 77–79 years. Medicaid eligibility in 2007 (based on the state buy-in variable) was used as a proxy of low socioeconomic status. Median income of the zip code was obtained from 2000 U.S. Census data based on zip code of residence in 2007 and stratified into quartiles. Approximately 5 percent of beneficiaries lived in zip codes missing income information.

Risk of colon cancer was estimated using ICD-9-CM codes obtained from claims in the year before monitoring. Beneficiaries with a family history of gastrointestinal cancer (V16.0), personal history of adenomatous polyps (V12.72), colorectal cancer (V10.05), rectal cancer (V10.06), Crohn’s disease (555.0-9), or ulcerative colitis (556.0-3, 556.8-9), noninfectious gastroenteritis and colitis (558.2, 558.9) were classified as high risk. For each patient the presence or absence of each comorbid condition included in the Elixhauser com-

orbidity index (Elixhauser et al. 1998) was determined using inpatient and outpatient claims. The Elixhauser index includes the following conditions: congestive heart failure, cardiac arrhythmias, valvular disease, pulmonary circulation disorders, peripheral vascular disorders, hypertension, paralysis, other neurologic disorders, chronic pulmonary disease, diabetes uncomplicated, diabetes complicated, hypothyroidism, renal failure, liver disease, peptic ulcer disease excluding bleeding, AIDS/HIV disease, lymphoma, metastatic cancer, solid tumor without metastasis, rheumatoid arthritis/collagen vascular diseases, coagulopathy, obesity, weight loss, fluid and electrolyte disorders, blood loss anemia, deficiency anemias, alcohol abuse, drug abuse, psychoses, and depression.

Statistical Analysis

The percentage of beneficiaries who had a colonoscopy in 2003–2007 was estimated for the total sample and separately for whites, blacks, and Hispanics by physician availability and area income. Chi-square tests were used to determine the statistical significance of differences in colonoscopy use between groups. Cochran-Armitage trend test was used to examine trends in colonoscopy use with increasing physician availability or income.

The effects of race/ethnicity and physician availability on colonoscopy use were estimated by hierarchical generalized linear mixed models with adjustment for patient characteristics and clustering of patients within HSAs. The odds ratios for black race and Hispanic ethnicity indicated the presence of disparities in receipt of colonoscopy. These odds ratios were compared across models before and after adjustment for colonoscopist and PCP availability to determine whether racial/ethnic disparities were attenuated after accounting for physician availability. We were also interested in whether the association between race/ethnicity and colonoscopy use varied by physician availability. Interactions between race/ethnicity and both measures of physician availability were tested and found to be statistically significant. Therefore, we also presented the odds ratios for racial/ethnic disparities separately for each quartile of colonoscopist availability and for each quartile of PCP availability to show how racial/ethnic disparities in colonoscopy use vary by level of physician availability in the HSA.

The follow-up period available for each patient varied by age. For example, beneficiaries aged 70 or older in 2007 had 5 years of claims data available for analysis, while those aged 66 in 2007 had only 1 year of claims data. As a result, differences in the age distributions of blacks, whites, and Hispanics

could potentially introduce bias in colonoscopy estimates. Therefore, a sensitivity analysis restricted to patients aged 70–79 years with five continuous years of claims data was performed. The multivariate analyses described in the previous paragraph were repeated using this restricted cohort. Results were substantively equivalent to those for the full cohort in regard to racial differences in receipt of colonoscopy, the effect of physician availability on the odds of receiving a colonoscopy, and the effect of physician availability on racial/ethnic disparities. Thus, we report only the results for the full cohort. A detailed version of the sensitivity analysis is available online (Appendix SA2).

All analyses were performed with SAS version 9.2 (SAS Inc., Cary, NC, USA).

RESULTS

Cohort characteristics are summarized in Table 1. The majority of patients were white (88.9 percent), between 66 and 73 years old (63.4 percent), female (55.6 percent), without high-risk indicators for colorectal cancer (93.4 percent), and with at least one comorbidity (53.6 percent). Table 2 shows the

Table 1: Characteristics of Medicare Beneficiaries in Texas, 2007

	<i>Overall</i>		<i>White</i>		<i>Black</i>		<i>Hispanic</i>	
	<i>N</i>	<i>%</i>	<i>N</i>	<i>%</i>	<i>N</i>	<i>%</i>	<i>N</i>	<i>%</i>
Total	974,879	100.0	866,828	100.0	70,202	100.0	37,849	100.0
Age								
66–69	335,656	34.4	300,177	34.6	26,050	37.1	9,429	24.9
70–73	282,875	29.0	255,176	29.4	20,758	29.6	6,941	18.3
74–76	190,206	19.5	169,222	19.5	12,813	18.3	8,171	21.6
77–79	166,142	17.0	142,253	16.4	10,581	15.1	13,308	35.2
Sex								
Male	432,910	44.4	387,190	44.7	28,381	40.4	17,339	45.8
Female	541,969	55.6	479,638	55.3	41,821	59.6	20,510	54.2
Risk of colon cancer								
No	911,084	93.5	808,851	93.3	66,633	94.9	35,600	94.1
Yes	63,795	6.5	57,977	6.7	3,569	5.1	2,249	5.9
Comorbidity								
No	452,043	46.4	410,311	47.3	25,975	37.0	15,757	41.6
Yes	522,836	53.6	456,517	52.7	44,227	63.0	22,092	58.4
Medicaid eligibility								
No	854,481	87.6	787,884	90.9	51,257	73.0	15,340	40.5
Yes	120,398	12.4	78,944	9.1	18,945	27.0	22,509	59.5

Table 2: Racial/Ethnic Composition of HSA by Quartile of Provider Availability and Income

	<i>Total</i> <i>N (%)</i>	<i>Whites</i> <i>N (%)</i>	<i>Blacks</i> <i>N (%)</i>	<i>Hispanics</i> <i>N (%)</i>
Overall	974,879 (100)	866,828 (88.9)	70,202 (7.2)	37,849 (3.9)
Overall colonoscopist availability*				
Q1 (0–4.8)	256,440 (100)	227,730 (88.8)	15,047 (5.9)	13,663 (5.3)
Q2 (4.8–6.9)	248,776 (100)	225,465 (90.6)	12,145 (4.9)	11,166 (4.5)
Q3 (6.9–8.5)	243,239 (100)	205,903 (84.7)	30,600 (12.6)	6,736 (2.8)
Q4 (>8.5)	226,424 (100)	207,730 (91.7)	12,410 (5.5)	6,284 (2.8)
PCP availability*				
Q1 (0–34.1)	247,470 (100)	221,222 (89.4)	13,590 (5.5)	12,658 (5.1)
Q2 (34.1–45.7)	242,281 (100)	219,323 (90.5)	10,271 (4.2)	12,687 (5.2)
Q3 (45.7–65.5)	237,874 (100)	216,450 (91.0)	14,700 (6.2)	6,724 (2.8)
Q4 (>65.5)	247,254 (100)	209,833 (84.9)	31,641 (12.8)	5,780 (2.3)
Zip code income [†]				
Q1 (\$4K–30K)	233,531 (100)	185,167 (79.3)	28,055 (12.0)	20,309 (8.7)
Q2 (\$30K–37K)	233,716 (100)	208,502 (89.2)	18,040 (7.7)	7,174 (3.1)
Q3 (\$37K–49K)	231,130 (100)	214,442 (92.8)	12,192 (5.3)	4,496 (1.9)
Q4 (\$49K–200K)	227,377 (100)	216,130 (95.1)	8,210 (3.6)	3,037 (1.3)

Notes. *Physician availability is the number of physicians/10,000 elders in the HSA.

[†]49,125 (5.04%) of subjects have zip codes without income information.

HSA, Hospital Service Area; PCP, primary care physician.

racial/ethnic composition of the HSAs by quartile of provider (colonoscopist and PCP) availability and income. HSAs in the lowest quartile of colonoscopist availability were 88.8 percent white, 5.9 percent black, and 5.3 percent Hispanic, while HSAs in the highest quartile were 91.7 percent white, 5.5 percent black, and 2.8 percent Hispanic. Blacks were somewhat more likely to live in an area with better physician availability while Hispanics were less likely to live in areas with better availability. Lower income zip codes had much higher percentages of blacks (12.0 percent) and Hispanics (8.7 percent) compared to higher income zip codes (3.6 and 1.3 percent, respectively).

Table 3 summarizes colonoscopy use based on colonoscopist availability, PCP availability in the HSA, and median income at the zip code level. Information is provided for the overall cohort and is also stratified by race and ethnicity. Overall, 39.8 percent of beneficiaries in the cohort had a colonoscopy between 2003 and 2007, inclusive. Also, 40.7 percent of whites had a colonoscopy during the study period, compared to 35.0 percent of blacks and 28.7 percent of Hispanics ($p < .001$).

Across racial/ethnic groups, colonoscopy use does not show a consistent pattern with increasing colonoscopist availability. Because of the size of

Table 3: Colonoscopy Use in Texas Medicare Beneficiaries by Area-Level Characteristics, 2003–2007

	Total		White		Black		Hispanic	
	N	Colonoscopy Use [†]	N	Colonoscopy Use ^{††}	N	Colonoscopy Use ^{††}	N	Colonoscopy Use ^{††}
Overall	974,879	39.8%	866,828	40.7%	70,202	35.0%	37,849	28.7%
Overall colonoscopist availability [§]								
Q1 (0–4.8)	256,440	39.2%	227,730	39.9%	15,047	37.3%	13,663	29.8%
Q2 (4.8–6.9)	248,776	39.3%	225,465	40.0%	12,145	35.8%	11,166	30.0%
Q3 (6.9–8.5)	243,239	40.6%	205,903	42.2%	30,600	33.7%	6,736	25.5%
Q4 (>8.5)	226,424	40.3%	207,730	41.0%	12,410	34.7%	6,284	27.1%
PCP availability [§]								
Q1 (0–34.1)	247,470	37.3%	221,222	37.9%	13,590	34.8%	12,658	28.3%
Q2 (34.1–45.7)	242,281	38.1%	219,323	38.8%	10,271	34.7%	12,687	30.0%
Q3 (45.7–65.5)	237,874	42.5%	216,450	43.2%	14,700	38.0%	6,724	29.4%
Q4 (>65.5)	247,254	41.6%	209,833	43.2%	31,641	33.8%	5,780	25.6%
Zip code income [¶]								
Q1 (\$4K–30K)	233,531	34.2%	185,167	34.8%	28,055	33.8%	20,309	29.1%
Q2 (\$30K–37K)	233,716	39.1%	208,502	39.7%	18,040	36.5%	7,174	27.5%
Q3 (\$37K–49K)	231,130	41.5%	214,442	42.2%	12,192	34.5%	4,496	29.3%
Q4 (\$49K–200K)	227,377	45.3%	216,130	45.8%	8,210	37.5%	3,037	30.3%

Notes. [†]There is a trend of increasing colonoscopy use with increasing colonoscopist or PCP availability in the total cohort and whites (Cochran-Armitage trend test, $p < .001$). There is also a trend for higher colonoscopy use with increasing income for the total population, whites, and blacks (Cochran-Armitage trend test, $p < .001$ for all the comparisons) but not Hispanics (Cochran-Armitage trend test, $p = .216$).

^{††}There is a significant difference in colonoscopy use among the three ethnic groups within each quartile of colonoscopist availability, PCP availability or income (chi-square test, $p < .001$).

[§]Physician availability is the number of physicians/10,000 elders in the HSA.

[¶]49,125 (5.04%) of subjects have zip codes without income information.

HSA, Hospital Service Area; PCP, primary care physician.

cohort, most comparisons will be statistically significant. Therefore, it is important to focus more on the magnitude of any differences rather than their statistical significance. For whites there was a slight increase in colonoscopy use as colonoscopist availability increased, while for blacks and Hispanics colonoscopy use decreased. A similar pattern was seen between availability of PCPs and colonoscopy. For HSAs in the lowest quartile of PCP availability, colonoscopy use for the overall cohort was 37.3 percent compared with 41.6 percent in the upper quartile ($p < .001$). This overall trend was accounted for by increased colonoscopy use among white patients, while blacks and Hispanics had no clear pattern in colonoscopy use as PCP availability increased.

There was a strong association between colonoscopy use and zip code-level income for the overall cohort, with higher income quartiles associated with higher colonoscopy use. This pattern is maintained in the white and black subgroups, but there does not appear to be a clear association between income level and colonoscopy use in Hispanics. A positive association between socioeconomic status and colonoscopy use was also evident when receipt of colonoscopy for Medicaid eligible patients was compared with those who were not eligible (30.3 percent and 41.2 percent, respectively, $p < .001$).

Table 4 presents the results of a multilevel analysis of the association of race/ethnicity with receipt of colonoscopy, independent of individual and area factors. After adjusting for age, sex, comorbidities, presence of risk factors for colon cancer, and income, the odds of colonoscopy were 20 percent lower for blacks (OR = 0.80, 95 percent CI 0.79–0.82) and 32 percent lower for Hispanics (OR 0.68, 95 percent CI 0.66–0.69) compared to whites (model 1).

Model 2 adds colonoscopist availability. Patients living in HSAs within the highest quartile of colonoscopist availability had somewhat higher odds of colonoscopy (OR = 1.09, 95 percent CI = 1.02, 1.18), while availability of PCPs in the HSA had no effect on receipt of colonoscopy (model 3). Neither availability of colonoscopists nor availability of PCPs affected the racial ethnic disparities in receipt of colonoscopies. The odds for blacks versus whites or Hispanics versus whites in receipt of colonoscopy did not vary when availability of colonoscopists or PCPs was entered into the model, either individually or together (models 2, 3, 4 of Table 4 versus model 1).

In the multilevel analyses presented in Table 4, there were significant interactions between either colonoscopist or PCP availability and black versus white or Hispanic versus white odds of receipt of colonoscopy (all $p < .001$). Therefore, in Table 5 we present the odds of black-white and Hispanic-white differences separately for each quartile of colonoscopist or PCP availability. The black-white and Hispanic-white disparities actually increased as

Table 4: Effect of Physician Availability on the Odds of Colonoscopy in Texas Medicare Beneficiaries by Multilevel Analysis

	<i>Odds Ratio (95% Confidence Interval)</i>			
	<i>Model 1</i>	<i>Model 2</i>	<i>Model 3</i>	<i>Model 4</i>
Race (black versus white)	0.80 (0.79, 0.82)	0.80 (0.79, 0.82)	0.80 (0.79, 0.82)	0.80 (0.79, 0.82)
Race (Hispanic versus white)	0.68 (0.66, 0.69)	0.68 (0.66, 0.69)	0.68 (0.66, 0.69)	0.68 (0.66, 0.69)
Comorbidity (yes versus no)	1.52 (1.51, 1.53)	1.52 (1.51, 1.53)	1.52 (1.51, 1.53)	1.52 (1.51, 1.53)
Risk of colon cancer (yes versus no)	3.14 (3.09, 3.20)	3.14 (3.09, 3.20)	3.14 (3.09, 3.20)	3.14 (3.09, 3.20)
Income (Q2 versus Q1)	1.12 (1.11, 1.14)	1.12 (1.10, 1.14)	1.12 (1.10, 1.14)	1.12 (1.10, 1.14)
Income (Q3 versus Q1)	1.29 (1.27, 1.31)	1.29 (1.27, 1.31)	1.29 (1.27, 1.31)	1.29 (1.27, 1.31)
Income (Q4 versus Q1)	1.50 (1.48, 1.52)	1.50 (1.47, 1.52)	1.50 (1.47, 1.52)	1.50 (1.47, 1.52)
Overall colonoscopist availability (4.8–6.9 versus 0–4.8)	–	1.08 (0.99, 1.19)	–	1.08 (0.98, 1.19)
Overall colonoscopist availability (6.9–8.5 versus 0–4.8)	–	1.12 (1.00, 1.26)	–	1.11 (0.99, 1.25)
Overall colonoscopist availability (>8.5 versus 0–4.8)	–	1.09 (1.02, 1.18)	–	1.09 (1.01, 1.18)
PCP availability (34.1–45.7 versus 0–34.1)	–	–	1.03 (0.96, 1.11)	1.02 (0.94, 1.10)
PCP availability (45.7–65.5 versus 0–34.1)	–	–	1.05 (0.95, 1.16)	1.03 (0.93, 1.14)
PCP availability (>65.5 versus 0–34.1)	–	–	1.02 (0.91, 1.14)	1.00 (0.89, 1.12)

Notes. Hierarchical generalized linear mixed modes adjusted for patient age and sex (not presented), as well as the variables shown.

PCP, primary care physician.

availability of colonoscopists in the HSA increased. For example, blacks living in HSAs in the lowest quartile of colonoscopist availability had 12 percent lower odds of colonoscopy, while blacks in the highest quartile of availability had 23 percent lower odds (Table 5).

Table 5: Effect of Colonoscopist and PCP Availability on the Racial/Ethnic Disparity in Colonoscopy Use by Multilevel Analysis

	Odds Ratio*	
	Black vs. White [†]	Hispanic vs. White [†]
Overall colonoscopist availability		
Q1 (0–4.8)	0.88 (0.84, 0.91)	0.74 (0.71, 0.77)
Q2 (4.8–6.9)	0.81 (0.78, 0.84)	0.75 (0.72, 0.78)
Q3 (6.9–8.5)	0.78 (0.76, 0.80)	0.52 (0.49, 0.55)
Q4 (>8.5)	0.77 (0.74, 0.80)	0.64 (0.60, 0.68)
PCP availability		
Q1 (0–34.1)	0.82 (0.79, 0.86)	0.76 (0.73, 0.79)
Q2 (34.1–45.7)	0.81 (0.77, 0.84)	0.76 (0.73, 0.79)
Q3 (45.7–65.5)	0.84 (0.81, 0.87)	0.60 (0.56, 0.63)
Q4 (>65.5)	0.78 (0.76, 0.80)	0.51 (0.48, 0.54)

Notes. *Adjusted with patient age, sex, comorbidity of the year before monitoring, the high-risk indicator for CRC of the year before monitoring, median income of zip code, and interaction between income and provider availability.

[†]For colonoscopist availability, the odds ratios in the first two quartiles are significantly higher than those in the last two quartiles for both black versus white and Hispanic versus white comparison ($p < .001$). For PCP availability, the odds ratios in the first two quartiles are significantly higher than those in the last two quartiles for Hispanic versus white comparison ($p < .001$) but not for black versus white comparison ($p = .746$).
PCP, primary care physician.

A similar pattern was seen for quartiles of PCP availability in Hispanics versus white comparisons. Hispanics living in HSA in the highest quartile of PCP availability had 24 percent lower odds of receiving colonoscopy, compared to whites, while Hispanics in the highest quartile of PCP availability had 49 percent lower odds. There were no clear differences in black versus white disparities by quartile of PCP availability (Table 5).

DISCUSSION

Our study evaluates the influence of colonoscopist and PCP supply on racial disparities in receipt of colonoscopy. We hypothesized that overall colonoscopy use in Medicare beneficiaries would increase with improved colonoscopist and/or PCP capacity and that black-white and Hispanic-white disparities in receipt of colonoscopy would diminish as supply increased. The results of our analyses do not support either of those hypotheses. Consistent with previous studies, we identified significant racial disparities in receipt of colonoscopy (Meissner et al. 2006; Ananthakrishnan et al. 2007; Fenton et al. 2009;

Doubeni et al. 2010). While increasing colonoscopist and PCP capacity was associated with increased colonoscopy use in whites, there was a decrease in blacks and Hispanics. As a result, the black-white and Hispanic-white disparities in receipt of colonoscopy actually increased as availability of colonoscopist and PCPs increased.

These data have important public health implications with regard to colorectal cancer screening. Other studies have demonstrated that capacity has little effect on health care access. Zuvekas and Taliaferro (2003), using data from the Medical Expenditure Panel Survey, demonstrated that physician capacity had little effect on access to health care. Furthermore, the increase in colorectal cancer screening rates over the last decade are largely driven by increased rates of colonoscopy (Meissner et al. 2006). Therefore, Meissner and colleagues (2006) suggested that promotion of colonoscopy as the preferred method of screening may actually serve to widen socioeconomic disparities, which is consistent with our findings.

Our data imply that increasing colonoscopist capacity alone may not improve colonoscopy use and may be associated with increased racial/ethnic disparities. This finding takes on more significance given that our study population was uniformly covered by Medicare Parts A and B. Previous studies have demonstrated disparities in the use of screening by educational attainment, income, health insurance coverage, receipt of routine medical care, characteristics of minority PCPs, geographic location, access to health care resources, population knowledge, cultural attitudes, health literacy, and socioeconomic disadvantage (Breen et al. 2001; Zuvekas and Taliaferro 2003; Seeff et al. 2004; Meissner et al. 2006). These barriers may be even more difficult to overcome if we continue to move toward colonoscopy as the preferred screening method (Meissner et al. 2006).

It is unclear why increased provider availability was associated with wider racial/ethnic disparities; however, it is likely that socioeconomic factors played a role. There is evidence that socioeconomically disadvantaged populations are slower to adopt complex medical innovations than more advantaged populations (Goldman and Lakdawalla 2005; Glied and Lleras-Muney 2008). Colonoscopy is invasive and time consuming, and involves a difficult preparation. In addition, Medicare coverage of screening colonoscopy for average-risk patients was only implemented in 2001, and even with coverage, colonoscopy is a costly procedure. Therefore, this phenomenon may be responsible for widening racial/ethnic disparities in the setting of increased provider availability, if more advantaged groups are more likely to follow through with this complex and costly screening procedure.

Another possibility is that the different associations between provider availability and colonoscopy use among whites, blacks, and Hispanics operated through individual-level income and income inequality within an HSA. Our analyses adjusted for a crude measure of contextual socioeconomic status, namely zip code-level income; however, residual confounding from individual-level differences in socioeconomic status is likely. Minority and white beneficiaries who reside in the same HSA may have very different socioeconomic status and live in neighborhoods and communities with very different income or education levels. Descriptive results from our study confirmed that lower income zip codes had much higher percentages of blacks and Hispanics compared to higher income zip codes. Minorities living in HSAs with higher provider availability may still lack access to the providers because they reside in poorer neighborhoods or communities or because of individual-level socioeconomic disadvantage. The increasing disparities noted with increasing colonoscopist availability may be driven by the relationship between income and colonoscopy use. We evaluated a three-way interaction between income, race, and colonoscopy availability. Within income quartiles, the pattern of increasing colonoscopist availability and increasing disparities is not as apparent while within provider availability quartiles there is a very apparent pattern of increasing disparities with increasing income. However, the interaction between race and availability remained significant after including the income/availability interaction. In addition, we also performed an HSA fixed effects model controlling for income, and the racial/ethnic differences persisted.

In contrast to our study, a recent study by Haas et al. (2010) reported a reduction in racial disparities for colorectal cancer screening with increasing colonoscopy capacity. Similar to our study they reported no association between PCP supply and colorectal cancer screening. There are methodological differences between the Haas study and our own that may explain the different results. Their study used data from the National Health Interview Survey, using a positive response to the question “Have you ever been screened for colorectal cancer, using FOBT, sigmoidoscopy, or colonoscopy?” as having been screened. In addition, they define capacity based on colonoscopies performed rather than providers. They use Medicare data based on the number of colonoscopies and sigmoidoscopies performed in the county in Medicare beneficiaries who are, by definition, 65 years or older. They then established a ratio per 100,000 residents aged 50 and older, including the subgroup of individuals between 50 and 64 years old, who were not counted in the total number of colonoscopies/sigmoidoscopies. Using their definition, the screening capacity for a county will vary based on the age

(50–64 versus 65+) and racial distribution of the county. In counties with higher proportions of the older population who are aged 65+, there will be more colonoscopies recorded (because colonoscopies are only measured for adults older than 65). Counties with very different actual Medicare screening rates could appear to have similar rates depending on the age distribution of the counties.

In contrast, we defined colonoscopist and PCP availability according to the number of physicians per 10,000 adults aged 65 and older in the HSA. These methodological differences may explain the difference in results. We included non-GI and GI colonoscopists in our final results, but the analysis was performed for GI colonoscopists only and the results were identical. Evaluating the two studies together, it may be that racial/ethnic disparities decrease with increasing numbers of colonoscopies (i.e., overall utilization rate) but not by the number of colonoscopists and PCPs (i.e., provider capacity).

There is a large body of evidence that suggests that patients with PCPs are more likely to receive colonoscopy and other important screening tests (Roetzheim et al. 2001; Selvin and Brett 2003; Liang et al. 2006; Meissner et al. 2006; Brouse, Wolf, and Basch 2008; Cardarelli, Kurian, and Pandya 2010). Our data support previous findings, demonstrating that increasing PCP supply does not increase colonoscopy use (Haas et al. 2010). Despite increasing PCP capacity, racial/ethnic minorities may not receive routine screening tests. In addition, when they do receive usual care, minority patients have been shown to be less likely to see PCPs who routinely perform screening (Bao, Fox, and Escarce 2007).

Our study has several limitations. We evaluated overall colonoscopy use without differentiating between screening and diagnostic colonoscopies. Medicare beneficiaries who had a colonoscopy before their enrollment in Medicare at 65 years old would be classified as not having received a colonoscopy in our analysis. Therefore, colonoscopy use for blacks might be under-reported as they have a higher proportion of beneficiaries in the younger age strata. However, sensitivity analyses conducted among patients aged 70–79 with 5 years of follow-up found similar results to those reported here for patients aged 66–79. Our estimates are not meant to represent overall “up-to-date” rates for colon cancer screening, which would require a longer time line for data acquisitions, as well as information on receipt of screening modalities such as sigmoidoscopy. Therefore, we focused on differences in colonoscopy use. In addition, we did not consider the number of colonoscopies performed by each colonoscopist, which may contribute to the understanding of the

observed trends. Also, Hispanics prefer to receive colorectal screening tests other than colonoscopy when compared to other racial/ethnic groups, which might decrease the total number of colonoscopies performed in this group (Sheikh et al. 2004; Meissner et al. 2006; Shokar, Carlson, and Weller 2007, 2008). Our cohort is restricted to Medicare beneficiaries older than 65 years old in the state of Texas only, and results might not be applicable to a national population or areas with younger populations. Texas is a state with recognized geographic variation in both utilization of health resources and health care costs. Moreover, the racial/ethnic composition of Texas is different than the national population, with 37.6 percent of Texas residents identifying as Hispanic according to 2010 U.S. Census data. There is evidence that disparities in colorectal cancer screening between blacks and whites (but not Hispanics and whites) vary across U.S. regions (Semrad et al. 2011). Disparities were driven by variation in screening rates among blacks, whereas whites had similar screening rates across regions. These results suggest that the underlying determinants of disparities, such as colonoscopist capacity or screening barriers, may differ regionally (Semrad et al. 2011). We included Medicaid eligibility as a crude measure of low socioeconomic status; however, a recent study showed that the state buy-in variable in the Medicare data does not adequately capture Medicaid eligibility (Koroukian et al. 2010). Finally, study findings were based on the cross-sectional observation of correlations between provider availability and colonoscopy use; therefore, it is not possible to make causal inferences or establish the direction of the association.

Our study has implications for public policy. An increased supply of providers may have little beneficial effect on ethnic and racial disparities in receipt of colonoscopy, as shown in this population of Texas Medicare beneficiaries. Indeed, there is the potential for disparities to widen. As more colonoscopists become available to satisfy the predicted increase in demand for screening colonoscopies in the future, further studies need to be performed to establish better allocation of colonoscopists. Finally, further explanation of the etiology of the increase in racial disparities associated with increased colonoscopist supply is required to avoid further increases in disparities as capacity expands to satisfy current needs.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Appendix SA1: Author Matrix.

Appendix SA2: Sensitivity Analysis Comparing Results between the Full Cohort and Patients Aged 70–79 Years.

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