

Variations in Colorectal Cancer Screening of Medicare Beneficiaries Served by Rural Health Clinics

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Abstract

This study aims (1) to examine the trends and patterns of colorectal cancer screening (CCS) of Medicare beneficiaries in rural areas by state and year (before and after Affordable Care Act [ACA] enactment) and (2) to investigate the contextual, organizational, and aggregated patient characteristics influencing variations in care received by patients of rural health clinics (RHCs). The following 2 hypotheses were formulated: (1) CCS rates are higher in the post-ACA period than in the pre-ACA period, irrespective of the factors rurality, poverty, dually eligible status, and the organizational characteristics of RHCs and (2) the contextual and organizational factors of RHCs exert more influence on the variation in CCS rates of RHC patients than do aggregated personal factors. We used administrative data on CCS rates (2007 through 2012) for rural Medicare beneficiaries. Autoregressive growth curve modeling of the CCS rates was performed. A generalized estimating equation of selected predictors was analyzed. Of the 9 predictors, 5 were statistically significant: The ACA and the percentage of female patients had a positive effect on the CCS rate, whereas regional location, years of RHC certification, and average age of patients had a negative effect on the CCS rate. The predictors accounted for 40.2% of the total variance in CCS. Results show that in rural areas of 9 states, the enactment of ACA improved CCS rates, contextual, organizational, and patient characteristics being considered. Improvement in preventive care will be expected, as the ACA is implemented in the United States.

Keywords

access to care, community health, managerial epidemiology, prevention, rural health

Introduction

Colorectal cancer has been identified as a major cause of cancer mortality in the elderly population. Hence, colorectal cancer screening (CCS) in adults aged 50 or older is advocated by the National Cancer Institute, the Centers for Disease Control and Prevention (CDC), the National Center for Health Statistics, and the US Preventive Services Task Force as well as by professional health care associations.¹ However, a 2013 CDC Vital Signs report estimated that more than one third of adults aged 50 to 75 years have not been screened for colorectal cancer as recommended by the US Preventive Service Task Forces.^{2,3} Many lives could be saved by this preventive screening.⁴

The enactment on March 23, 2010, of the Patient Protection and Affordable Care Act (ACA) has been expected to increase the use of appropriate preventive practices and in particular CCS for Medicare beneficiaries. Since the ACA implementation, medical insurance plans have been expected to provide CCS with no deductible amount applied. The use of multiple

years of administrative data generated for the Centers of Medicare and Medicaid Services (CMS) can effectively examine the ACA effect on changes in preventive practice between the pre- and the post-ACA period. Our development of a rural health clinic (RHC) database, covering 6 years—with the pre-ACA period (2007 through 2009) and a post-ACA period (2010 through 2012)—enabled the examination of trends and patterns of rural disparities in CCS. The study is centered on rural Medicare beneficiaries served by RHCs in 8 states of region 4 when compared to those in California. The reason for

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selecting a comparison state is that California is an early adopter of innovative delivery systems with emphasis on preventive care services: health maintenance organizations, community health centers, RHCs, and accountable care organizations. California's performance in preventive care services could serve as a benchmark for region 4.

Black–white gaps in mortality rates for colorectal cancer were well recognized by the American Cancer Society's 2014 Cancer Statistics Report.⁵ Using national data from the CDC's Behavioral Risk Factor Surveillance System (BRFSS) that documented the CCS practice (including colonoscopy, fecal occult blood test, and flexible sigmoidoscopy), the American Cancer Society's report⁶ showed the state variations in CCS rates by combining the totals for those beneficiaries having had a fecal occult blood test in the past 12 months and those having had a flexible sigmoidoscopy in the past 5 years as reported by the survey respondents in 9 states: Alabama (57.2%), California (60%), Florida (63.8%), Kentucky (61.1%), Georgia (61.6%), Mississippi (53.4%), North Carolina (65.5%), South Carolina (62.8%), and Tennessee (59.5%). The gender, age, rural–urban, and racial differences in the screening practices were consistently noted in the analysis of self-reported data generated from the BRFSS.⁷

Regional variations in health care and patient outcomes are urgent matters for policy analysis. In particular, the southeastern states or the Department of Health and Human Services (DHHS) region 4 (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee) have a large proportion of impoverished persons and cope with environmental threats, have higher rates of obesity, and low levels of access to primary care services. The ACA, targeting prevention and improvement in the population's health insurance coverage, may help to reduce the gaps in preventive practice. Because a significant number of underserved populations were identified in region 4,^{8,9} exploration of the effect of ACA implementation on regional variations in CCS of older adults in rural areas is called for.

The purpose of this study is 2-fold: (1) to examine trends and patterns of CCS of Medicare beneficiaries in varying sizes of rural areas by state and year (before and after ACA enactment) and (2) to investigate the contextual (state, poverty level, rurality, and ACA period effect), organizational (years of operation, staff size, provider-based practice, and Accountable Care Organization (ACO) affiliation), and aggregated patient characteristics (age, gender, dually eligibility status, and racial distributions of patients) influencing practice variations. Two research questions are investigated: (1) Are there disparities in utilization of CCS by RHC patients between the pre-ACA and post-ACA periods in RHCs located in region 4 and in California? and (2) What are the relative influences of contextual, organizational, and aggregated patient factors on the variations in CCS in the 9 states?

Two hypotheses were formulated for this empirical study. The first hypothesis is that CCS rates are higher in the post-ACA period than in the pre-ACA period, irrespective of the factors of rurality, poverty, dually eligible (recipients of both Medicare and Medicaid) status, and the organizational characteristics of RHCs. The second hypothesis is that contextual and organizational

Table 1. The Number of Distribution for RHC Studied for Colorectal Cancer Screening of Rural Medicare Beneficiaries by State and Year.^a

Colorectal Cancer Screening Observation							
Number of Distribution of RHCs by State and Year (2007-2012)							
State	2007	2008	2009	2010	2011	2012	Total
California	73	90	85	90	90	89	517
Alabama	28	41	39	37	41	40	226
Florida	64	65	61	63	69	65	387
Georgia	39	56	51	49	52	53	300
Kentucky	76	92	90	88	89	90	525
North Carolina	58	64	66	59	55	54	356
South Carolina	46	52	54	54	59	51	316
Tennessee	17	34	26	30	32	32	171
Mississippi	75	86	93	93	85	91	523
Total	476	580	565	563	572	565	3,321

Abbreviation: RHCs, rural health clinics.

^aN = 3321 RHC years.

factors of RHCs exert more influence on the variation in CCS rates of RHC patients than do aggregated personal factors.

Methods

Design and Data Sources

We conducted a longitudinal analysis of administrative data for 600 RHCs gathered from 4 sources: (1) the CMS Chronic Condition Data Warehouse master beneficiary summary file, (2) the Institutional Outpatient Claims File, (3) the Area Health Resource File, and (4) Provider of Services File. The CCS prevalence rates (2007 to 2012) were captured in the CMS Medicare claims data and calculated as the total number of Medicare beneficiaries who were screened for colorectal cancer divided by the total number of patients served by each RHC per year. The screening rates were relatively low when compared to self-reported data generated from the BRFSS and the National Health Interview Survey of older adults. The focus of the present analysis, however, is on utilization of CCS by Medicare beneficiaries in RHCs to inquire how those variations can be accounted for by contextual, organizational, and aggregated patient factors. The RHC is the unit of analysis.

The total of rural older adults studied ranged from 243 860 Medicare beneficiaries in 2007 to 280 829 in 2012. We excluded 225 RHCs where the total number of patients was not reported. We retained 600 RHCs as a panel from the study sample. After eliminating the clinics with missing information on CCS, we had a total of 3312 RHC-year observation from 2017 through 2012 (Table 1). The clinics distributed by state and year included in the study are presented in Table 2. Medicare beneficiaries were assigned to RHCs based on where they had the greatest number of visits and where the distance from the beneficiary's ZIP code of residence was shortest. Beneficiaries with end-stage renal disease were excluded from the panel.

Table 2. Colorectal Cancer Screening Rates of Medicare Beneficiaries by Pre- and Post-ACA Periods and State in Rural Areas.

CCS/state	Pre-ACA			Post-ACA		
	2007	2008	2009	2010	2011	2012
California	2.24%	3.34%	3.23%	2.96%	2.85%	3.13%
Region 4						
Alabama	1.13%	2.05%	1.60%	1.50%	1.83%	2.18%
Florida	1.15%	1.16%	1.08%	1.38%	1.39%	1.79%
Georgia	1.99%	2.13%	2.30%	2.59%	2.40%	3.07%
Kentucky	1.88%	2.55%	2.34%	2.10%	2.90%	3.09%
Mississippi	1.26%	1.73%	1.64%	2.02%	2.21%	2.72%
North Carolina	1.56%	2.13%	1.81%	1.92%	2.44%	2.39%
South Carolina	1.65%	2.74%	2.52%	2.50%	2.58%	2.96%
Tennessee	1.33%	1.43%	1.40%	1.11%	1.58%	1.45%

Abbreviations: ACA, Affordable Care Act; CCS, colorectal cancer screening; CMS, Centers of Medicare and Medicaid Services.

^aThe CCS procedures are documented in the CMS database. Only Medicare payments for CCS were identified.

The codes for CCS were retrieved from the Medicare claims documents. Cancer screening utilization was coded as “user” (coded as 1) or “nonuser” (coded as 0). Because our available data did not capture the Current Procedure Terminology/Health Care Financing Administration Common Procedural Coding System (CPT/HCPCS) codes, we used relevant diagnosis codes from CMS’s Outpatient Claims file to identify patients who had undergone CCS. The reliability of diagnosis codes versus CPT codes for tracking CCS service should be carefully examined in the future.

Measurements

Independent variables. Three categories of predictor variables at the RHC level were created: (1) contextual, (2) organizational, and (3) aggregated personal factors. The contextual variables derived from the Health Resources and Services Administration (HRSA) Area Health Resource File were percentage of population in poverty, rurality (4 levels), racial composition, state, and the ACA period effect. A dichotomized predictor variable was created to show the potential period effect of the ACA on CCS rates of Medicare beneficiaries in RHCs: before 2010 (2007 through 2009) coded as 0 and after 2010 (2010 through 2012) coded as 1. The organizational factors include years of RHC operation, physician–staff ratio and staff size, provider-based practice, and ownership. Personal attributes of Medicare beneficiaries aggregated to the RHC level include size of Medicare beneficiaries served, average patient age, percentage of female patients served, percentage of African American patients served, percentage of patients dually eligible, and diagnostic mix indicators.

Dependent variables (CCS Rate and CCS Disparity Ratio). The literature suggests numerous ways to construct health disparities.¹⁰ The formulas for computing the screening rate as a yearly prevalence measure and disparity ratios as a relative gap between each year and a reference year (2009) are as follows:

An annual rate of CCS = (the number of Medicare patients screened for colorectal cancer divided by the total number of Medicare beneficiaries served by each RHC per year) \times 100.

Disparity ratio of CCS = (the deviation of an annual rate from the reference average rate or “annual rate of CCS” in 2009, divided by this reference rate) \times 100.

Colorectal screening was only performed on a patient without any symptoms presented. Therefore, patients who had received CCS were identified by *International Classification of Diseases, Ninth Revision, Clinical Modification* codes V76.41 and V76.51. The deviation from an average rate or a norm is used to compare the changes in screening rates for RHC beneficiaries as suggested by the National Center for Health Statistics.¹⁰ Here the average rate of all study RHCs in 2009 is used as a reference value. Thus, for the percentage deviation from the 2009 average CCS rate per year, a positive value indicates a higher CCS rate for the RHC’s Medicare beneficiaries than the average rate for RHC Medicare beneficiaries in 2009, and a negative value indicates a lower rate compared to the average.

The data from 2007 to 2012 were pooled in the analysis. Thus, the unit of analysis for a dependent variable is referred to as the “RHC-year” with a CCS rate deviated from that of the 2009 rate for 600 RHCs in the 9 states. This measure of the percentage of deviation from a reference point is interpretable, enabling portrayal of the variation when considering impact of ACA. Because the distribution of the disparity ratio is normalized, the analysis of variability can detect the patterns or trajectories of change.

Analytical Methods

Three statistical methods were used to analyze the pooled cross-sectional data, in a process similar to a time series without using a panel group of RHCs in a longitudinal analysis. First, descriptive statistics captured general characteristics of the RHCs in region 4 and in California. Second, the autocorrelations of CCS rates for the 6 years were examined by correlation analysis and growth curve modeling. Third, regression of the dependent variable on selected predictor variables clustered in 3 categories was performed by a generalized estimating equation (GEE) method, using the SAS Institute’s GENMOD procedure.

The GEE method is a semiparametric approach to longitudinal analysis of repeated measurements introduced by Liang and Zeger.¹¹ The statistical assumptions are as follows: (1) the repeated measures or responses to be correlated or clustered, (2) covariates with a mixture of predictor variables and their interaction terms, (3) no requirement for equal variance or homogeneity of variance, (4) correlated errors assumed to be independent, (5) no multinormal distributions assumed, and (6) a quasi-likelihood estimation rather than maximum likelihood estimation to estimate the parameters. The robustness of a GEE model is determined by Akaike’s Information Criterion such as Quasi-likelihood under the Independence Model Criterion. A marginal R^2 value was computed to reflect the total

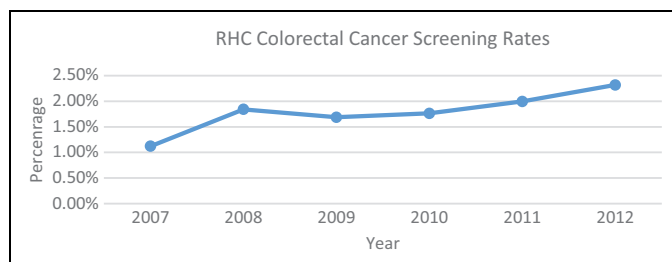


Figure 1. Trend plot for colorectal cancer screening rates of Medicare beneficiaries in 600 RHCs by year. RHCs indicates rural health clinics.

variance explained by the predictor variables.¹²⁻¹⁴ We performed hierarchical regression of a continuous response variable on the contextual, organizational, and aggregate personal predictors separately and kept statistically significant variables for the final equation.

Results

Comparing CCS Rates of RHC Patients Between the Pre- and Post-ACA Periods

For CCS rates of Medicare beneficiaries at the RHC level, all 8 states in region 4 have slightly lower rates than RHCs in California do (Table 2). Rates were higher in the post-ACA period than in the pre-ACA period. For all 6 years, Medicare beneficiaries of RHCs located in Kentucky had higher CCS rates than did those of other region 4 states. It is interesting to note that in 2008, 7 of 9 states (excepting Florida and Georgia) had a relatively higher rate during the pre-ACA period. The increase in this year may be induced by policy interventions such as health reforms or state budget allocations for public health services during the pre-ACA period.

Trends in CCS Rates of Medicare Beneficiaries Served by RHCs

A steady increase in CCS rates since 2009 was observed (Figure 1). The rate in 2012 was almost 50 points higher than that in 2009. For each of the 6 years, the CCS rate of each RHC was compared to a selected norm “average rate for 2009.” The percentage of deviations from this mean were calculated—the higher a positive value, the higher the utilization of CCS by patients of the RHCs.

Autocorrelation and Latent Growth Curve Modeling of CCS Rates (2007-2012)

Serial correlations of CCS rates in 6 years were evaluated. The correlations were moderately and positively associated. Thus, the potential threat of serial correlation of the rates had to be examined using autoregressive latent growth curve modeling and analysis.¹⁵ Figure 2 shows the autoregressive model of

6 waves of CCS rates for Medicare beneficiaries of 600 RHCs. The model was formulated to examine the relationship between the 2 latent growth components, the intercept (I_{csr}) reflecting the initial status and the slope (S_{csr}) of yearly rates. The model shows the trajectories of rate change. This autoregressive growth curve model fits the data very well with a chi-square value of 20, 7 degrees of freedom; Normal Fix Index (NFI) = 0.989, Tucker-Lewis Index (TLI) = 0.978, Comparative Fix Index (CFI) = 0.993, and Root Mean Square Error of Approximation (RMSEA) = 0.048. A positive and statistically significant association between each rate and its following yearly rate was found. The correlation between the intercept (initial status) and the slope (change speed) is only weakly related (0.08). The relationships between each annual rate and the intercept were, respectively, 0.61, 0.44, 0.49, 0.47, 0.38, and 0.35 from 2007 through 2012. The relationships between each annual rate and the slope were 0.00, 0.09, 0.20, 0.28, 0.30, and 0.35 for the respective years, showing a steady increase in CCS.

Generalized Estimating Equation Analysis of Predictors

For the examination of repeated measures of the disparity ratio of 3321 RHC years, GEE analysis followed a 2-step hierarchical regression: (1) the disparity ratio variable was regressed independently on each group of predictors (contextual, organizational, and aggregated patient attributes) and (2) using a backward selection method, only statistically significant predictors from each group of predictors were combined in the second step of regression analysis. Because the effect of rurality on CCS has not been explored in the literature, in the final regression equation we added the 3 dummy variables (large rural, small rural, and isolated rural areas, with RHCs located in urbanized areas as a reference group). Table 3 presents the results of statistically significant predictors for the disparity measure. To illustrate the relative importance of each predictor, the table includes standardized regression coefficients (parameter estimates) and relevant statistics. For a given predictor variable, a positive regression coefficient suggests that the CCS utilization rate was higher than the average rate for 2009 (the pre-ACA year as a reference point). A negative coefficient suggests a rate worse than the 2009 average rate. A marginal R^2 for each estimating equation was also computed to show the total variance in the dependent variable explained by all predictors.

Table 3 also reveals several statistically significant findings. First, the ACA period had a net and positive effect on Medicare beneficiaries served by RHCs in the utilization of CCS. Second, Medicare beneficiaries in region 4 states had a lower rate of CCS than did those of California. Third, no statistically significant differences in disparities in CCS rates were found by rural classifications. Fourth, years of operation were inversely related to screening rates. Fifth, older RHC patients had a lower rate of CCS. Sixth, RHCs serving more female patients had higher screening rates. Seventh, the percentage of the dually eligible was not related to the screening rate. The total variance explained by 9 predictors was 40.2%.

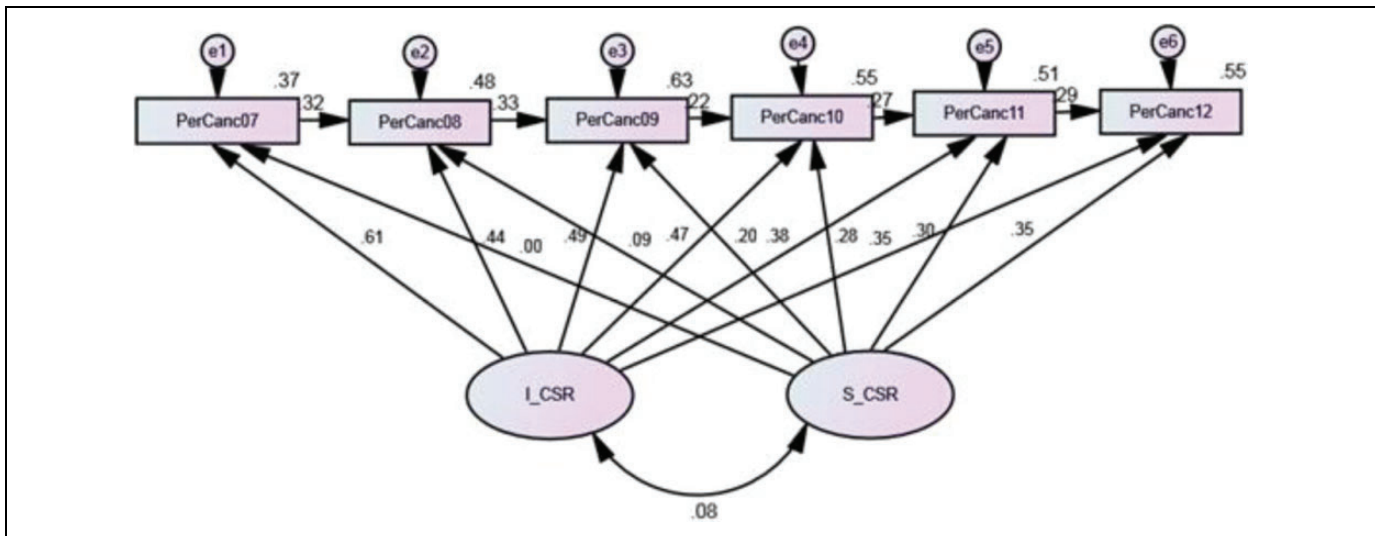


Figure 2. An autoregressive growth curve model of colorectal cancer rates of Medicare beneficiaries served by RHCs (2007 through 2012). RHCs indicates rural health clinics.

Table 3. Analysis of GEE Parameter Estimates for Predictors of Disparities in Colorectal Cancer Screening Rates of Medicare Beneficiaries Served by RHCs.^a

Standardized Estimates						
Parameter	Estimate	Standard Error	95% Confidence Limits		Z	Pr > Z
ACA period effect	0.0374	0.0127	0.0126	0.0622	2.95 ^c	.0031
Region 4	−0.1293	0.0307	−0.1894	−0.0691	−4.21 ^c	<.0001
Large rural area	0.0242	0.0334	−0.0413	0.0898	0.72	.4689
Small rural area	0.0214	0.0319	−0.0412	0.0839	0.67	.5027
Isolated rural area	0.0607	0.0415	−0.0206	0.1420	1.46	.1436
Years of operation	−0.0612	0.0256	−0.1114	−0.0111	−2.39 ^c	.0167
Average age of patients	−0.2321	0.0366	−0.3038	−0.1604	−6.34 ^c	<.0001
% female patients	0.1116	0.0366	0.0399	0.1834	3.05 ^c	.0023
% dually eligible	−0.0203	0.0358	−0.0904	0.0498	−0.57	.5702

Abbreviations: RHC, rural health clinic; GEE, generalized estimating equation; ACA, Affordable Care Act; QIC, Quasi-likelihood under the Independence Model Criterion

^aN = 3,321 RHC years.

^bMarginal R square value = 0.402, QIC = 3375, QICu [an adjusted index for quasi-likelihood under the Independence Model Criteria (QIC)] = 3333.

^cZ-statistics greater than or equal to |1.96| are statistically significant at .05 or lower level.

Discussion

By exploring the data compiled from administrative and cost data from multiple sources, this research reveals an important, positive period effect of the ACA on CCS rates in rural areas of the 9 states. Thus, the first hypothesis is confirmed by the data. This important finding highlights the beneficial ACA effect on CCS in rural communities.

The GEE found that the ACA period effect, regional location, years in operation, and percentage of female patients in RHCs exert more influence than did the other predictors on CCS rates. Thus, the test results on the second hypothesis are mixed. Although the empirical findings are robust, they are subject to a few methodological limitations. For example, since the CCS rates of Medicare beneficiaries

served by RHCs are based on the CMS's Outpatient Revenue Center file, this variable was constructed using administrative and payment data. It may underestimate the magnitude of the screening procedures performed for residents of rural areas.

Given that the purpose of this investigation was to analyze the variability in the CCS utilization rates, identification of RHC years with lower than the CCS average rate in 2009 in the screening rates for the elderly beneficiaries can also exemplify the need to improve access to preventive services by the Medicare beneficiaries of certain RHCs. Meanwhile, the highest CCS rate vis-à-vis the reference year of 2009 can identify a subset of RHCs, showing the highest CCS rates among their Medicare beneficiaries.

For lack of information from claims data files, this study could not explore personal barriers (knowledge/information fluency about colorectal cancer and patient-doctoral communication) that were predictors of cancer screening.¹⁶⁻¹⁹ The generalizability of the regional variation in CCS practice is limited to 9 states only. Among the 8 states in region 4, negligible state variations in CCS were found, although Kentucky appeared to have higher rates in the 6 years studied. It also showed that region 4 viewed as a whole had a lower screening rate than did the state of California. Because the present analysis of CCS prevalence was based on the diagnostic codes of colorectal cancer, not the current procedural terminology codes, the estimation of prevalence rates of CCS may have underestimated the total annual number of CCS.

Notwithstanding the limitations noted earlier, this investigation establishes that more CCS of younger and female Medicare beneficiaries was found. Another finding is that rural area classifications do not help to explain the disparities in CCS rates. Future studies could address the variation in types of CCS procedures performed for Medicare beneficiaries served by RHCs. One potential avenue for investigation is to assess different types of screening interventions to detect colorectal cancer.

Conclusion

The impact of the ACA on rural health, which has important implications for policy, requires empirical investigation. Overall, our study offers robust evidence that higher utilization rates of CCS by Medicare beneficiaries were found in the post-ACA period than in the pre-ACA period. This finding for the 9 states shows that CCS rates improved after the enactment of ACA, with other contextual, organizational, and patient characteristics simultaneously considered. The expansion of Medicaid and preventive care coverage under the ACA may further solidify the vision of reducing health care disparities.²⁰

Years of certification as an RHC was inversely related to the screening rate. This finding may imply that those RHCs with more years of RHC certification might have a smaller number of older adults served or are more likely affiliated with hospitals that would provide more colonoscopy for patients of RHCs. The causal link between organizational design and outcomes of screening intervention should also be explored, so that evidence-based preventive screening by RHCs could be established using best practices for colorectal cancer prevention.

This study contributes to the literature on health disparities research from contextual, organizational, and patient perspectives in the analysis of longitudinal data. The results show that it is no single dominant factor operates alone in the occurrence of disparities. Certainly, one cannot assume that only race or ethnicity causes the differences in CCS utilization in RHCs.²¹ Investigation of the interplay or synergism of multiple factors, as shown in this study, is a necessary step for improving the state of health disparities research.

Declaration of Conflicting Interests

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