Section Editor: Theresa Wicklin Gillespie

ORIGINAL RESEARCH

Persistent Poverty, Rural Location, and Racial Segregation are Factors in Colorectal Cancer Screening in Low-Income and Uninsured Populations

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Authors' disclosures of conflicts of interest are found at the end of this article.

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https://doi.org/10.6004/jadpro.2025.16.7.14

Abstract

Purpose: This study aimed to investigate the correlation between geographical factors, including rurality, persistent poverty counties, racial residential segregation, and adherence to colorectal cancer (CRC) screening among low-income uninsured and underinsured individuals in Texas. **Methods:** Utilizing retrospective survey data collected by the A&M Texas Cancer Screening program from 2011 to 2022, linear mixed-effects models were employed. The models examined CRC screening adherence within the recommended time frame as the primary outcome, with geographical county-level characteristics (rurality, racial residential segregation, and persistent poverty) as the main predictors, controlling for other sociodemographic variables. **Findings:** The linear mixed-effects analysis revealed that individuals residing in counties characterized by high racial residential segregation (OR = 0.54, 95% CI = 0.36–0.79) or persistent poverty (OR = 0.65, 95% CI = 0.45–0.92) were less likely to self-report having undergone any type of CRC screening within the recommended time frame compared to those in counties with lower racial residential segregation and non-persistent poverty. Conversely, residents of rural counties were more likely to report being up to date with CRC screening compared to their urban counterparts (OR = 1.8, 95% CI = 1.27–2.55). **Conclusions:** The findings underscore the need for more targeted CRC screening promotion strategies tailored to low-income, uninsured populations residing in disadvantaged areas such as rural and persistent poverty counties, as well as those characterized by high racial residential segregation.

J Adv Pract Oncol 2025

Colorectal cancer (CRC) is the second most common cause of cancer fatalities in the United States (Siegel et al., 2025). Estimates suggest that in 2025, approximately 154,270 individuals will receive a CRC diagnosis, resulting in around 52,967 deaths (Siegel et al., 2025). Timely detection of CRC is pivotal, with approximately 91% of those diagnosed at a localized stage surviving beyond 5 years, while 14% of those diagnosed at a late stage achieve this milestone (Petrelli et al., 2017; Siegel et al., 2023). The CRC screening objective, set by Healthy People 2030, is a 68.3% screening rate (U.S. Preventive Services Task Force, 2021). Additionally, the U.S. Preventive Services Task Force (USPSTF) and the American Society of Colon & Rectal Surgeons have evidence-based recommendations for regular CRC screening. However, populations lacking insurance exhibit lower screening rates (20%–40%; Joseph et al., 2020; Gupta et al., 2014; Green & Meenan, 2020). Notably, besides insurance coverage, residing in disadvantaged neighborhoods (i.e., neighborhoods with higher housing costs, higher unemployment, less secure, lower income, with higher racial residential segregation) predicts reduced screening adherence, after adjusting for socioeconomic status (Lozano et al., 2023; Knott et al., 2020; Ibekwe et al., 2021). These factors contribute significantly to survival outcomes.

Neighborhood environment can impact health behaviors independent of individual characteristics (e.g., age, race, income, education; Lozano et al., 2023; Knott et al., 2020; Ibekwe et al., 2021). Disadvantaged areas (e.g., rural, persistent poverty, racial residential segregation) are characterized as intricate societal dysfunctions, manifesting directly as stressors (e.g., poor access to care, lack of health professionals) or indirectly through community circumstances (e.g., limited access to healthy foods or lack of exercise facilities), leading to unhealthy behaviors (Joseph et al., 2020; Gupta et al., 2014; Green & Meenan, 2020; Lozano et al., 2023; Knott et al., 2020; Ibekwe et al., 2021; Chrisman et al., 2015; Kegler et al., 2022). While segregation is no longer legal in the United States, the impact of previous policies, including redlining, has resulted in racial residential segregation (Moss et al., 2022a; Ibekwe et al., 2022; Scally et al., 2018; Mobley et al., 2017; Kruse-Diehr et al., 2021; Zhou et al., 2017).

Several studies suggest that perceived racial discrimination, racial residential segregation, and rural residence each contribute to lower cancer screening adherence and increased mortality (Moss et al., 2022a; Scally et al., 2018; Mobley et al., 2017; Kruse-Diehr et al., 2021; Ibekwe et al., 2022; Zhou et al., 2017; Theodoropoulos et al., 2022a; Shete et al., 2021). However, there are inconsistent findings regarding the effects of racial residential segregation on cancer screening adherence rates (Zhou et al., 2017; Benjamins, 2012; Facione & Facione, 2007; Hausmann et al., 2008; Shariff-Marco et al., 2010; Dailey et al., 2007).

Persistent poverty counties are characterized as counties where 20% or more of the population has been living below the household poverty level for the past 40 years (Moss et al., 2020). Living in these regions consistently predicts diminished cancer screening adherence. Furthermore, it correlates with heightened cancer mortality rates, even when adjusting for age, education, and race (Bevel et al., 2023; Kruse-Diehr et al., 2021; Moss et al., 2020; Papageorge et al., 2023). Additionally, rurality predicts CRC screening adherence and subsequent outcomes (Moss et al., 2022a; Moss et al., 2020; Ojinnaka et al., 2015; Rogers et al., 2020; Lewis-Thames et al., 2022; Carmichael et al., 2020; Paddison & Yip, 2010; Preston et al., 2018; Goodwin et al., 2019). Research shows rural residents are less likely to follow screening recommendations, which contributes to worse CRC survival (Moss et al., 2020; Ojinnaka et al., 2015; Rogers et al., 2020; Lewis-Thames et al., 2022; Carmichael et al., 2020; Paddison & Yip, 2010; Preston et al., 2018; Goodwin et al., 2019; Wang et al., 2019).

Evidence indicates an association between residing in disadvantaged areas and encountering barriers impeding CRC screening adherence (Paddison & Yip, 2010; Preston et al., 2018; Goodwin et al., 2019). These barriers include financial burden, lack of insurance, social stigma, limited access to providers, medical mistrust, and inadequate knowledge or perception of the necessity for CRC screening (Paddison & Yip, 2010; Wang et al., 2019). While these studies offer insights into how residency characteristics can affect CRC screening adherence, they primarily focus on the

general population, rather than specifically targeting uninsured populations with lower incomes.

Factors contributing to disparities in CRC screening adherence among the uninsured population in Texas remain incompletely understood. However, nonadherent behavior may be influenced by various residential characteristics. Consequently, this study aimed to investigate the relationship between neighborhood environment and CRC screening adherence among low-income and uninsured populations in Texas—more specifically, the impact of racial residential segregation, persistent poverty, and/or rurality on CRC screening adherence.

METHODS

Study Population

The Texas Cancer Screening, Training, Education, and Prevention Program (C-STEP) offers complimentary diagnostic colonoscopy services to uninsured and underinsured individuals with a household income at or below 250% of the federal poverty level. From 2011 to 2022, C-STEP provided colonoscopy services to 2,885 participants residing in Health Professional Shortage Areas (HPSAs; primarily rural areas). Participants were recruited through C-STEP outreach events held primarily in 21 counties within central Texas, with help from 10 community health workers (CHWs) and designated clinical sites. Figure 1 shows participants' county characteristics. This study focuses on individuals aged between 45 and 75, who were asked about their history of previous cancer screening prior to receiving services through the C-STEP program. Their reported screening behaviors were compared in accordance with the recommendations of the USPSTF for CRC screening (USPSTF, 2021). This program was approved by the Texas A&M Institutional Review Board protocol 2013-0885 and 2022-0543.

Measures and Data Sources

The primary outcome variable in this study was individuals' adherence to the recommendations set forth by the USPSTF and the American Society of Colon & Rectal Surgeons regarding regular CRC screening. This variable was binary, with responses categorized as "Yes" or "No," and it relied on self-reported survey data. To classify participants as adherent, they self-reported undergoing one of the CRC screening methods within specified time frames (Table 1). Otherwise, their status was recorded as nonadherent. Responses indicating "unknown" were treated as missing data since the focus is on CRC screening adherence.

The model in this study incorporated county-level and individual-level covariates. County-level factors include racial residential segregation, rurality, and persistent poverty, while individual-level factors include age group, gender, and race. The primary independent variables in this study were the county-level indicators for the neighborhood environment (rurality, high racial residential segregation counties, and persistent poverty counties). Data for these variables were derived from the American Community Survey, which gathered 5-year estimates from 2017 to 2021 (University of Wisconsin Population Health Institute, 2024).

Racial residential segregation was determined using the Black/White Residential Segregation Index (RSI). This index serves as a demographic metric assessing the equitable distribution of Black and White residents across various geographic areas within a larger region (University of Wisconsin Population Health Institute, 2024). Index values range from 0, indicating complete integration, to 100, signifying complete segregation (University of Wisconsin Population Health Institute, 2024). It can be seen as the percentage of Black or White residents that would need to relocate to different geographic areas to achieve a distribution comparable to that of the region (University of Wisconsin Population Health Institute, 2024). In this study, the participants were situated within 32 counties in Texas, and the mean value of the RSI is 40.2, with a range of 17 to 59. This index was dichotomized into a binary variable based on this mean. An index exceeding the mean was categorized as 1, while an index falling below the mean is categorized as 0.

Rurality was categorized into a binary variable, distinguishing between urban and rural areas. This categorization is based on the Rural-Urban Continuum Code (RUCC) framework provided by the United States Census Bureau (Economic Research Service, U.S. Department of Agriculture, 2024). RUCC codes 1 to 3 are designated for urban areas within metropolitan regions with populations of less than 250,000, between 250,000 and 1 million, and more than 1 million, respectively, classifying

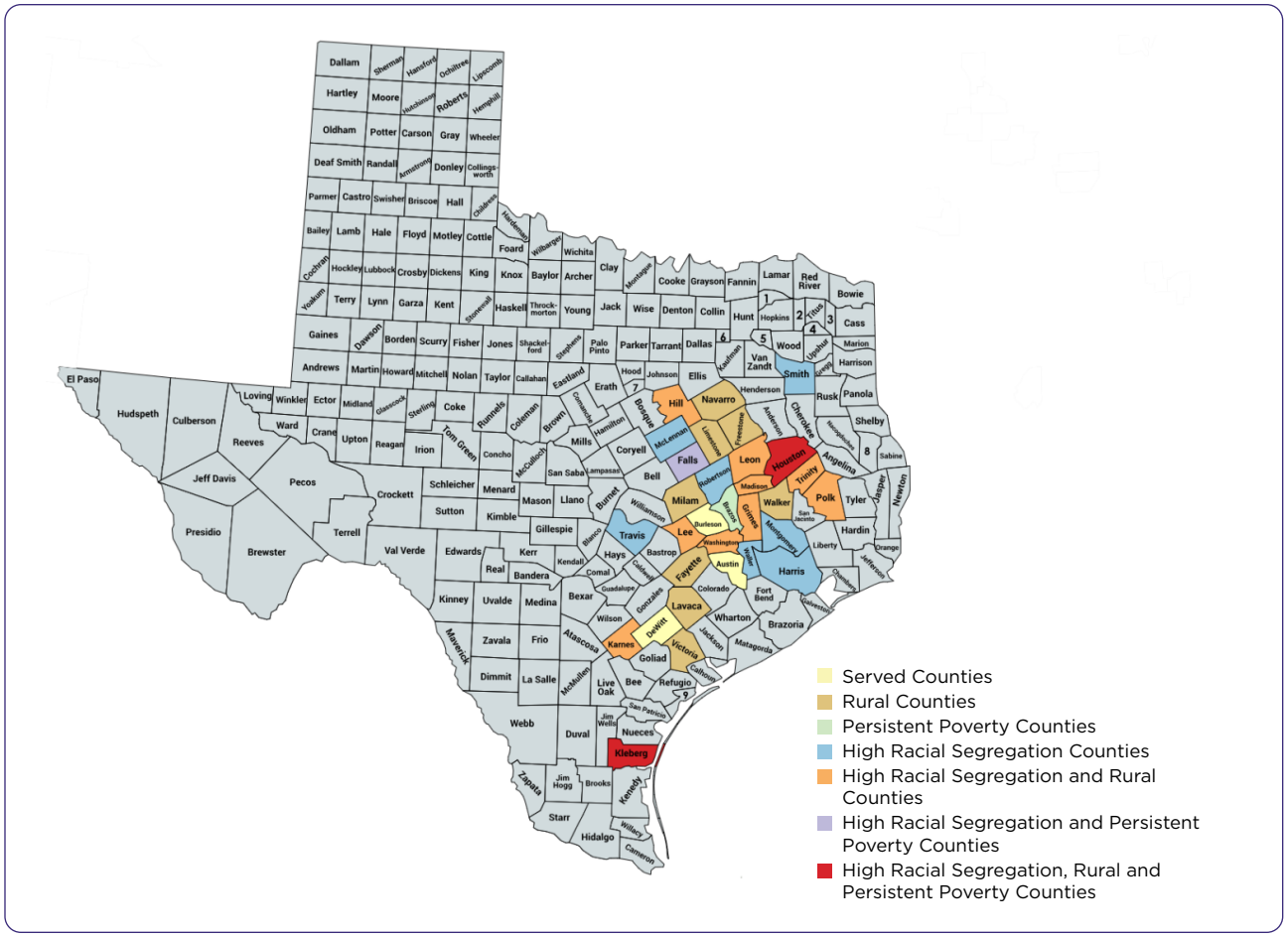

Figure 1. County characteristics of C-STEP participants. This identifies the counties within the C-STEP Catchment area that met at least one or a combination of the criteria (persistent poverty, rural, high racial residential segregation).

them as having metropolitan status (RUCC = 1–3; Economic Research Service, U.S. Department of Agriculture, 2024). In contrast, RUCC codes 4 to 9 represent rural areas. Nonmetropolitan status is determined by combining counties with urban populations ranging from 2,500 to 19,999 people, or 20,000 or more, and entirely rural counties or urban counties with populations below 2,500 people (RUCC = 4-9; Economic Research Service, U.S. Department of Agriculture, 2024).

Persistent poverty counties are defined by the United States Census Bureau as counties with a poverty rate of ≥ 20% among residents from 1989 to 2015 to 2019 (Benson et al., 2023). In 2019, 341 persistent poverty counties were identified, with approximately 80% of them located in the Southern region (Benson et al., 2023). In this study, 57.82% of program enrollees resided in persistent poverty counties.

Regarding age groups, individuals within the age range recommended by USPSTF were included and divided into three groups. The average age of the participants was 56 years. Age groups were categorized as 45 to 54, 55 to 64, and 65 to 75 years old. Ethnicity and race were consolidated into a categorical variable, including Hispanic White, Non-Hispanic White, Black, and Other/Unknown.

Statistical Analysis

Initially, cross-tabulation was conducted to examine the frequency of adherence along with the percentage distribution of individual-level and community-level characteristics. Pearson's chi-squared test was then applied to assess the

association between these characteristics and the outcomes of CRC screening adherence. For the multivariable analysis, a generalized linear mixed-effects models with logit link function was employed. More specifically, the fixed effect was set to include all individual-level characteristics (age, race/ethnicity, and gender) and the random effect to include counties. This analysis presented estimated odds ratios (ORs) along with their corresponding 95% confidence intervals (CIs) to display the relationships between participant characteristics and CRC screening adherence.

To ensure the robustness of the results, a subset analysis was conducted, focusing on comparing differences between the sample age groups. In this phase, age groups were classified into < 45, 45 to 75, and > 75 years old, and a logistic regression analysis was conducted with the same set of covariates. This approach was taken because individuals under the age of 45 or above 75 are outside the recommended age range for CRC screening adherence. Additionally, these age groups may be influenced differently by factors affecting adherence. In all analyses, statistical significance was considered when the two-sided p value was less than or equal to 0.05. The statistical analyses were performed using Stata software version 17, 2021.

Table 1. Colorectal Cancer Screening Recommendations

Screening test	Frequency
Fecal occult blood test	Every year
Fecal immunochemical test	Every year
DNA testing	Every 3 years
CT colonography	Every 5 years
Flexible sigmoidoscopy	Every 5 years
Barium enema	Every 5 years
Flexible sigmoidoscopy + fecal immunochemical test	Every 10 years + every year
Colonoscopy	Every 10 years

Note. Based on USPSTF and the American Society of Colon & Rectal Surgeons recommended screening tests and time frames.

RESULTS

Descriptive Characteristics

The study sample size was 2,885 individuals who completed surveys as part of the C-STEP program. These survey responses were analyzed to explore the complex interplay of individual and county characteristics within distinct strata, as presented in Table 2. In this program, 78% of participants did not follow CRC screening guidance. In terms of age distribution, approximately 40% of participants were between 45 to 54 years old, 39% between 55 and 64 years old, and 8% in between 65 and 74 years old ($p < .001$). The survey findings revealed 67% identified as female, while 33% identified as male. In terms of race and ethnicity, about 35% identified as Non-Hispanic White, 28% as Hispanic White, and 18% as Black. The remaining 19% either identified as other races, being of unknown ethnicity, or having missing data ($p = .11$). When examining residential distribution, 63% of participants resided in counties with a racial residential segregation index below 40%, while the remaining 37% lived in areas where the index exceeded 40% ($p = .96$). Regarding residency classification, urban and rural designations were not evenly distributed in the sample. Approximately 72% were classified as urban, with the remaining 28% classified as rural ($p = .31$). Furthermore, 58% of participants lived in persistent poverty counties, while 42% did not ($p = .05$).

Model Results

Table 3 presents the results of the mixed-model analysis, with a focus on the second model encompassing both patient- and county-level predictors. The analysis revealed residential disparities in CRC screening adherence (Table 3). The findings identified adherence to CRC screening recommendations decreases with higher levels of Black-White racial residential segregation. Specifically, individuals residing in counties with an RSI exceeding 40% had statistically lower odds of adherence with CRC screening compared to counties with an index below 40% (OR 0.54, CI = 0.36–0.79, $p = .002$). Individuals living in persistent poverty counties had statistically lower odds of undergoing recommended cancer screening compared to those in non-persistent poverty counties (OR 0.65, CI = 0.45–0.92, $p = .016$). Interestingly, rural residents were more likely to undergo CRC screening compared with

Table 2. Descriptive Characteristics of Individual Colorectal Cancer Screening Adherence

Characteristics	Total (*N* = 2,885), *N* (%)	Nonadherent (*N* = 2,251), *N* (%)	Adherent (*N* = 634), *N* (%)	*p* value
Age				< .001
45–54	1,144 (40%)	975 (43%)	169 (27%)	
55–64	1,137 (39%)	840 (37%)	297 (47%)	
65–75	224 (8%)	143 (6%)	81 (13%)	
Missing	380 (13%)	293 (13%)	87 (14%)	
Gender				.23
Female	1,936 (67%)	1,498 (67%)	438 (69%)	
Male	949 (33%)	753 (33%)	196 (31%)	
Race/ethnicity				.11
Non-Hispanic White	996 (35%)	760 (34%)	236 (37%)	
Hispanic White	814 (28%)	651 (29%)	163 (26%)	
Black	534 (19%)	406 (18%)	128 (20%)	
Other	93 (3%)	74 (3%)	19 (3%)	
Unknown	107 (4%)	92 (4%)	15 (2%)	
Missing	341 (12%)	268 (12%)	73 (12%)	
Racial segregation index[a]				.96
< 40%	1,811 (63%)	1,416 (63%)	395 (62%)	
≥ 40%	1,061 (37%)	825 (37%)	236 (37%)	
Missing	13 (0%)	10 (0%)	3 (0%)	
Persistent poverty county[b]				.05
Yes	1,668 (58%)	1,323 (59%)	345 (54%)	
No	1,217 (42%)	928 (41%)	289 (46%)	
Rurality[c]				.31
Urban	2,072 (72%)	1,632 (73%)	440 (69%)	
Rural	800 (28%)	609 (27%)	191 (30%)	
Missing	13 (0%)	10 (0%)	3 (1%)	

Note. [a]The County Health Rankings & Roadmaps (CHR&R) program at the University of Wisconsin Population Health Institute uses American Community Survey (ACS) data from 2017-2021 to measure racial/ethnic residential segregation, which assesses how different racial groups live separately in a geographic area. The level of segregation is evaluated on a scale from 0 to 100, indicating the evenness in the distribution of these groups.
[b]The United States Census Bureau designates an area as experiencing persistent poverty if its poverty rate was 20% or higher from 1989 to 2015-2019 over three decades.
[c]The 2013 Rural-Urban Continuum Codes (USDA) classify counties based on metro area population size for metropolitan counties and urbanization level and proximity to a metro area for nonmetropolitan counties. The RUCC code ranges from 1 to 9. RUCC codes 1 to 3 are designated for urban areas, while 4 to 9 represent rural areas.

their urban counterparts (OR = 1.8, 95% CI = 1.27–2.55, $p < .000$).

Shifting focus to individual characteristics, the odds ratio for individuals aged 55 to 64 vs. those aged 45 to 54 years was 2.15 (CI = 1.71–2.71, $p < .000$), while the odds ratio for individuals aged 65 to 75 vs. those aged 45 to 54 was 3.85 (CI = 2.72–5.44, $p = .000$). Furthermore, race/ethnicity and gender did not significantly impact CRC screening adherence.

DISCUSSION

Exploring the potential impact of residency characteristics on CRC screening is pivotal in refining

Table 3. Mixed Method Multilevel Generalized Linear Regression With Logit Link Log, Odds Ratios of Individuals Comply With Colorectal Cancer Screening Recommendation

	Model 1 (Adjusting for individual characteristics)			Model 2 (Adjusting for individual and community characteristics)[a]		
Variable	**OR**	**95% CI**	***p* value**	**OR**	**95% CI**	***p* value[b]**
Age group						
45–54	Reference			Reference		
55–64	2.14	1.7–2.69	.000	2.15	1.71–2.71	.000**
65–75	3.8	2.68–5.38	.000	3.85	2.72–5.44	.000**
Gender						
Female	Reference			Reference		
Male	0.88	0.71–1.1	.274	0.89	0.71–1.11	.297
Race/ethnicity						
Non-Hispanic White	Reference			Reference		
Hispanic White	0.99	0.77–1.29	.995	1.03	0.8–1.33	.823
Black	1.01	0.77–1.33	.930	1.03	0.78–1.35	.849
Other	0.91	0.519–1.62	.751	0.93	0.52–1.65	.8
Unknown	0.54	0.29–0.99	.048	0.54	0.29–1.01	.054*
Racial segregation index						
< 40%				Reference		
≥ 40%				0.54	0.36–0.79	.002**
Persistent poverty county						
No				Reference		
Yes				0.65	0.45–0.92	.016*
Rurality						
Urban				Reference		
Rural				1.8	1.27–2.55	.000**

Note. [a]In model 2, individual-level characteristics (age, race/ethnicity, and gender) were set as fixed effect, while counties were set as random effect.
[b]*if *p* value < 0.1, ** if *p* value < 0.05, and ** if *p* value < 0.01.

strategies to promote CRC screening, particularly for populations residing in disadvantaged areas. This study leveraged data from a state-wide CRC screening program to delve into county-level predictors of CRC screening adherence among low-income, uninsured individuals within the recommended age range, residing in central Texas. The findings revealed a mere 22% adherence with CRC screening recommendations among participants. The odds of CRC screening adherence were notably associated with both neighborhood and individual characteristics, shedding light on variations observed across the counties within our program.

Prior research has investigated demographics such as age, race/ethnicity, gender, and residential attributes concerning CRC screening (Buehler et al., 2019; Sepassi et al., 2024). This analysis found that individuals aged 55 to 64 exhibited twice the odds of CRC adherence compared to those aged 45 to 54, while those aged 65 to 75 showed 3.85 times the odds of adhering to CRC screening recommendations, both of which were statistically significant. This aligns with evidence from the Behavioral Risk Factor Surveillance System survey, indicating 68.8% of U.S. adults within the recommended age range are up to date with CRC screening (Joseph et al., 2020). However, it also highlights disparate adherence rates among age groups. Specifically, individuals aged 50 to 54 exhibit the lowest adherence rate at 50%, while the

rate increases with age, rising from 63.3% among those aged 50 to 64 to 79.2% among those aged 65 to 75 (Joseph et al., 2020). The differential utilization of CRC screening across various age groups is influenced by multiple risk factors, including Medicare coverage (Medicare Part B is often required to receive screening), disability status, and age-specific barriers. Medicare coverage is a strong predictor of access to care due to its age-specific eligibility, with more than 97% of U.S. citizens over age 65 being covered (Lindstrom, 2024a). Having health insurance and better access to care may increase the probability of CRC screening completion among older populations. In addition, research indicates that screening completion rates are lower among younger populations due to work-related constraints that limit their ability to take time off, reliance on high-deductible employee insurance plans, and a perception of better health (Liu et al., 2022). Furthermore, for uninsured and low-income individuals in this study, unstable employment and income may further exacerbate disparities in CRC screening utilization. These factors may aggregately contribute to delayed screening among younger populations. Future strategies should be directed toward promoting screenings within the uninsured population, particularly among those who do not qualify for Medicare (individuals under the age of 65). This targeted approach may alleviate disparities evident across different age cohorts.

The analysis revealed no significant difference in screening patterns between males and females (p = .297). National studies present conflicting findings; some suggest males are less likely to undergo CRC screening (Clarke et al., 2015; Valery et al., 2020; Sabatino et al., 2022; Brawarsky et al., 2003), while others indicate no gender disparity (Valery et al., 2020). Conversely, another study suggests males exhibit higher adherence to fecal occult blood tests or fecal immunochemical tests compared to females (Lin et al., 2021). Consistency of CRC screening adherence across genders, years, and procedures remains inconclusive (Clarke et al., 2015; Valery et al., 2020; Sabatino et al., 2022; Brawarsky et al., 2003; Lin et al., 2021). Qualitative research highlights that, relative to men, women harbor greater concerns regarding invasive CRC screening procedures (Friedemann-Sánchez et al., 2007). Women perceive preparations for screening procedures as invasive, expressing fears related to body exposure during the procedures. Additionally, women demonstrate a preference for more screening information compared to men (Friedemann-Sánchez et al., 2007).

Research demonstrates an association between residing in racially segregated areas and reduced adherence to CRC screening (Zhou et al., 2017; Theodoropoulos et al., 2022a; Benjamins, 2012; Facione & Facione, 2007; Hausmann et al., 2008; Shariff-Marco et al., 2010; Dailey et al., 2007; Segura & Siddique, 2023). Factors such as perceived discrimination and medical mistrust emerge as determinants explaining why racial residential segregation contributes to poorer adherence (Ibekwe et al., 2022). Racial minority populations encounter challenges such as lower incomes, lack of insurance, discrimination, residing in healthcare professional shortage regions, and limited access to health services (Ibekwe et al., 2022). The study findings support this evidence, indicating residing in counties characterized by higher racial residential segregation is associated with 0.54 times lower odds of complying with CRC screening. However, the study found race/ethnicity alone did not affect CRC screening adherence. This finding suggests that among low-income uninsured populations, the impact of residing in racially segregated residential areas—adjusting for age, gender, and other residency characteristics—on CRC screening adherence is more significant. Within disadvantaged areas, environmental contexts contribute to barriers to CRC screening and reduced self-efficacy (Hallgren et al., 2023). Individuals living in neighborhoods with a high ethnic density face increased perceived barriers to screening, subsequently impacting screening rates (Hall et al., 2022).

According to the American Association for Cancer Research, individuals residing in persistent poverty counties experience significantly higher CRC mortality compared to those in non-persistent poverty counties (Moss et al., 2020). In addition, despite lower CRC screening rates, areas marked by poverty exhibit higher CRC incidence and mortality compared to affluent regions (Scally et al., 2018; Kruse-Diehr et al., 2021; Zhou et al., 2017; Moss et al., 2020; Moss et al., 2022b; Papageorge et al., 2023). This corresponds to this

study's findings: individuals in persistent poverty areas exhibit 0.65 times lower odds of complying with CRC screening. Barriers to CRC screening in poverty-stricken areas include challenges related to transportation, limited availability of health-care workers, and CRC screening stigmatization (Unger-Saldaña et al., 2020; Jin & Yoon, 2020; Agunwamba et al., 2023). Notably, the study sample comprised solely low-income individuals without coverage. This finding emphasizes that even within income levels, the environment exerts considerable influence on screening.

The findings reveal no distinction in CRC screening adherence based on rurality. However, existing research highlights disparities in CRC screening adherence, incidence, and mortality between rural and urban populations (Joseph et al., 2020; Theodoropoulos et al., 2022a; Shete et al., 2021; Moss et al., 2020; Moss et al., 2022b; Papageorge et al., 2023; Zhou et al., 2017; Ojinnaka et al., 2015; Rogers et al., 2020; Lewis-Thames et al., 2022; Carmichael et al., 2020; Paddison & Yip, 2010; Preston et al., 2018; Goodwin et al., 2019; McDaniel et al., 2019). In addition, expanded access to screening services and providers is needed in rural areas (Bloom et al., 2023). Income may act as a mediator, affecting the relationship between rurality and adherence to screening protocols. Notably, this study exclusively enrolled a low-income population without coverage, potentially explaining the lack of association between rurality and CRC screening adherence, as rural populations are more likely to be uninsured or underinsured, particularly in Texas (Day, 2019).

To address demographic disparities in colorectal cancer (CRC) screening, nurse practitioners (NPs) in both primary care and oncology play key roles, particularly in underserved areas. Primary care NPs are essential in identifying at-risk patients and ordering the appropriate screening tests. In all states, NPs can order laboratory tests for CRC screening, although it may require physician supervision (Feeney, 2024). In some states and health systems, NPs are also able to perform visual screening methods (Riegert et al., 2020). Additionally, oncology-trained NPs can collaborate with their primary care counterparts to provide education on CRC screening recommendations, develop high-quality cancer screening programs (including design, measurement, evaluation, and optimization), and engage in cancer screening-oriented policy making (Mehta et al., 2016; Podmore et al., 2024).

More than half of NPs provide health services in rural areas (Zwilling et al., 2021), and about 30% work in HPSAs; Barnes et al., 2018). Research indicates the need for colorectal screening is ever-increasing with the screening guidance shift from starting at age 50 to 45, but the number of endoscopists is decreasing (Ramalingam et al., 2024). In 2017, a study identified that current colonoscopy capacity in the United States can only serve 80% of the national population (Joseph et al., 2016). The disparity is worse in rural and disadvantaged areas, where there is less density of endoscopists residing (Aboagye et al., 2014; Ananthakrishnan et al., 2010; Xu et al., 2022). To fill the gap, NPs serving in underserved areas can address disparities through their unique roles by educating and ordering other types of colorectal cancer screening tests. However, these NPs may not always be aware of current recommendations and at-risk populations, particularly those from low-income and uninsured backgrounds residing in underserved areas (Laird & Raudonis, 2020; Slyne et al., 2017). Marginalized populations often lack access to CRC screening due to financial constraints and limited access to physicians and screening facilities. Nurse practitioners in underserved areas can play a critical role in promoting CRC screening by engaging in targeted outreach processes. Understanding how geographic limitations hinder individuals' ability to comply with CRC screening is crucial for NPs to design effective engagement plans for the marginalized population in underserved areas.

Limitations

While this study presents insights into CRC screening adherence within the uninsured low-income population, there are several limitations. Primarily, the participants exhibit homogeneity due to recruitment based on specific socioeconomic criteria. Enrollees were selected because their household income was ≤ 250% of the federal poverty level and their lack of insurance. These factors might introduce confounding effects, potentially overshadowing the influence of

residency characteristics on CRC screening outcomes by mediating these associations. Additionally, approximately 20% of the race data and over 50% of the insurance data were missing from this sample. If the missingness is non-random, that may introduce selection bias and affect the validity of the study findings. The C-STEP program provides free cancer screening for uninsured and low-income populations residing in central Texas. Texas has a high proportion of Hispanic immigrants often excluded from Medicaid and similar programs due to their immigrant status—a characteristic shared by our participants. Language barriers, health literacy issues, and cultural factors could pose significant obstacles to CRC screening. Consequently, these sample characteristics limit the generalizability of these findings.

CONCLUSION

This study uncovered disparities in CRC screening adherence at individual and residency characteristics. Notably, residing in higher racial residential segregation areas and living in persistent poverty areas made it less likely for uninsured individuals to seek CRC screening services, even after adjusting for individual characteristics. Further investigation is needed exploring how specific environmental characteristics impact decisions, CRC screening adherence, and CRC outcomes. This approach would help develop targeted strategies to promote cancer screening among vulnerable populations. ●

Acknowledgment

The authors express their gratitude for the contributions of Texas A&M University's School of Medicine, School of Nursing, School of Public Health, Community Health Workers team, cooperated clinics, healthcare workers, and community stakeholders who participated in the program. They assisted in engaging participants, delivering navigation services, and offering free cancer screenings.

The CPRIT cancer screening program is funded by Cancer Prevention and Research Institute of Texas (grant# PP110176, PP150025, PP180037 and PP220013) and reviewed by Texas A&M Institutional Review Board protocol (IRB # 2013-0885 and 2022-0543). For further information, contact: Rosaleen D. Bloom, PhD, APRN, ACNS-BC, AOCNS, School of Nursing, Texas A&M University, 3950 N A.W. Grimes Blvd., Round Rock, TX, 78665. Email: rdbloom@tamu.edu.

Disclosure

The authors have no conflicts of interest to disclose.

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