

Factors associated with colorectal cancer screening among U.S. adults: A cross-sectional study using NHIS 2023 data

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ABSTRACT

Introduction: Colorectal cancer (CRC) remains a leading cause of cancer-related mortality in the USA. Although early detection via screening significantly reduces morbidity and mortality, national uptake rates remain suboptimal, particularly among underserved populations. Understanding the multifaceted factors influencing CRC screening adherence is essential for guiding targeted public health interventions.

Objective: This study used a nationally representative sample to identify demographic, socioeconomic, and behavioral factors associated with CRC screening adherence among U.S. adults aged 45-75 years.

Methods: A cross-sectional analysis was conducted using the 2023 national health interview survey (NHIS) data. Adults aged 45-75 years who reported CRC screening history were included. The primary outcome was up-to-date screening per U.S. Preventive Services Task Force guidelines. Independent variables were guided by Andersen and Davidson's behavioral model of health services use and included demographic characteristics, socioeconomic status, and healthcare access. Multivariable logistic regression analyses were conducted using weighted survey procedures.

Results: The study showed that 68.2% of the adults were up-to-date with CRC screening. Screening rates increased with age and education and were higher among individuals with health insurance and a regular source of care. Compared to non-Hispanic whites, minority groups, particularly Hispanic, non-Hispanic Black, and non-Hispanic Other, exhibited lower screening rates. Access to care, including insurance coverage and a usual care provider, emerged as the strongest predictors of adherence. Individuals who lacked U.S. citizenship, insurance, or faced transportation and cost-related barriers were significantly less likely to be screened.

Conclusion: Disparities in CRC screening persist, especially among younger adults, racial/ethnic minorities, and the socioeconomically disadvantaged. Expanding insurance coverage and strengthening provider engagement are key drivers to improve screening uptake.

Keywords: colorectal cancer, screening, disparities, NHIS, USA

INTRODUCTION

Colorectal cancer (CRC) is the third most common cancer and the fourth leading cause of cancer-related death worldwide [1]. In 2020, there were approximately 1.9 million new CRC cases and 930,000 deaths globally, with projections estimating a rise to 3.2 million new cases and 1.6 million deaths by 2040 [2]. In the USA, CRC is the third most common cause of cancer-related death in both men and women [3]. Each year, over 130,000 Americans are diagnosed with, and over 49,000 people die from the disease [4]. The management of CRC is associated with substantial healthcare costs, with national expenditures exceeding \$14 billion annually [5].

CRC risk rises considerably after age 50, and other risk factors include family history, inflammatory bowel illness, and lifestyle choices such as food, inactivity, smoking, and alcohol

intake [6]. The disease is often asymptomatic in its early stages and is frequently diagnosed at advanced stages, contributing to higher mortality rates and treatment costs [6, 7]. Early detection through screening is critical, as it identifies precancerous polyps and early-stage lesions that can be treated appropriately [2]. The implementation of screening programs has increased overall survival and the prospect of a cure for CRC [2].

Current guidelines recommend several screening methods, including colonoscopy every 10 years, annual fecal immunochemical tests (FIT), or multi-target stool DNA tests every three years [8, 9]. Despite these recommendations, screening uptake rates remain suboptimal in the USA and globally. In the USA, only about 58% of adults aged 50 to 75 had received guideline-recommended testing in 2018 [7]. Significant disparities exist, with lower screening rates among certain demographic groups, particularly among African

Americans and Hispanic individuals with limited English proficiency [10]. Black Americans are 20% more likely to develop CRC and 35% more likely to die from it compared to other groups. However, they are screened at substantially lower rates, with only slightly more than 50% of eligible individuals receiving recommended screening [10]. Socioeconomic factors, such as poverty and lack of insurance, are other key barriers to CRC screening [11].

In an attempt to boost this critical need for colorectal screening and reduce disparities, the services administration (HRSA) has implemented targeted interventions through federally qualified health centers (FQHCs), which provide primary care services to over 30 million underserved individuals across the USA [12]. Recent data from HRSA's uniform data system revealed that FQHCs achieved a 41.1% CRC screening rate in 2023, screening over 3.3 million adults aged 45-75 [13]. While this represents significant progress, it remains well below national targets. While disparities in screening rates are consistently reported, comprehensive studies examining the multifaceted barriers specific to minority and socioeconomically disadvantaged groups, which can explain the limited national average uptake, are limited.

Our study addresses these gaps by examining demographic factors, such as age, gender, race, and ethnicity, associated with CRC screening uptake, emphasizing understanding disparities among diverse populations. We also aim to examine socioeconomic factors, including income, education level, and insurance coverage, impacting screening behavior, particularly for underserved populations with historically lower screening rates. Additionally, we analyze behavioral factors, such as awareness of CRC and screening options, and lifestyle choices, that influence the decision to undergo CRC screening, especially among those with limited healthcare access. These objectives will yield insights to guide initiatives to raise CRC screening rates, particularly among groups that experience disproportionate CRC burdens.

MATERIALS AND METHODS

This cross-sectional study design is based on data from the 2023 national health interview survey (NHIS), a nationally representative survey conducted annually by the National Center for Health Statistics. Through structured household interviews, the NHIS collects health-related information from civilians of the civilian population ages 18 years and older, non-institutionalized adults in the USA. The dataset includes self-reported responses regarding health behaviors, chronic conditions, and preventive care utilization, including CRC screening. Detailed descriptions of NHIS sampling and data collection procedures are available at <https://www.cdc.gov/nchs/nhis/index.htm> (accessed 7 March 2025).

Eligible participants included in this study were adults aged 45 to 75 years who responded to the NHIS questionnaire on CRC screening, regarding whether they had a screening test and when using at least one of the screening modalities: home high-sensitivity guaiac fecal occult blood test (HSgFOBT) or FIT, stool DNA-FIT (sDNA-FIT), computed tomography colonography, flexible sigmoidoscopy, flexible sigmoidoscopy, colonoscopy and cologuard test. This age range aligns with the U.S. Preventive Services Task Force (USPSTF) 2021 guidelines, which recommend routine CRC screening for individuals within this group [14]. The final analytic sample excluded respondents

with missing, refused, or uncertain responses for CRC screening variables.

Measures and Variables

CRC screening uptake

The primary outcome was CRC screening uptake, defined as adherence to any USPSTF-recommended screening modalities within the appropriate timeframes. A detailed list of screening modalities and timeframes is provided in **Appendix A**. Participants were classified as not having a recommended CRC screening if they never underwent screening or had one test outside the USPSTF-recommended frequency.

Independent variables

Andersen and Davidson's seminal article on access to care in America guided the selection of independent variables [15]. Predisposing factors, including, demographic, socioeconomic, and behavioral and health characteristics were examined as potential correlates of CRC screening adherence.

1. Demographic variables included sex (male and female), age (45-49, 50-55, 56-64, 65-75), race (non-Hispanic White, non-Hispanic Black, Hispanic, non-Hispanic other), region (Northeast, Midwest, South, West), and U.S. (yes, no).
2. Socioeconomic factors included educational attainment (below high school, high school graduate, associate or bachelor's degree, master's degree or higher), marital status (married, living with partner together as an unmarried couple, neither), income from wages (yes and no), ratio of income-to- poverty (income below poverty line, income above poverty line), transportation-delayed care (yes, no), care place (yes, no), insurance (yes, no), worry about paying medical bills (very worried, somewhat worried, not at all worried), and delayed medical care due to cost (yes, no).
3. Behavioral and health factors included smoked 100 cigarettes or more (yes, no), difficulty with social activity (none, some, a lot, cannot do), and body mass index (BMI) (underweight, healthy, overweight, obese).

Statistical Analysis

The NHIS employs a complex survey design to obtain a representative sample of the US population. Accordingly, all statistical analyses accounted for the survey design by incorporating strata, clusters, and sampling weights. Descriptive statistics, including unweighted frequencies and weighted percentages, were used to characterize the study population. A Chi-squared test with Rao-Scott adjustment was used to study the bivariate associations between independent variables and the outcome (up-to-date screening). A p-value cutoff of 0.05 was considered for the univariate Chi-squared test to identify candidate variables for inclusion in the multivariable model. Multivariable logistic regression was utilized to study the impact of each independent variable on the outcome. Results from the multivariable model were presented as adjusted odds ratio (AOR) and their corresponding 95% confidence intervals (CI). Variables with AOR whose CIs excluded 1.00 were considered statistically significant. Complete case analysis was performed to base our analysis solely on the observed data. All analyses were conducted using SAS statistical software, version 9.4.

Table 1. Characteristics of the survey participants from NHIS 2023 (N = 15,092)

Variables		UF	W % ± SE
Up-to-date screening	Yes	10,737	68.2 ± 0.50
	No	4355	31.8 ± 0.50
Sex	Male	7,003	48.6 ± 0.5
	Female	8,087	51.4 ± 0.5
Age (years)	45-49	1,948	16.5 ± 0.39
	50-55	2,614	20.8 ± 0.42
	56-64	4,569	31.5 ± 0.45
	65-75	5,961	31.3 ± 0.44
Race	Non-Hispanic White	10,514	66.1 ± 0.81
	Non-Hispanic Black	1,761	11.4 ± 0.48
	Hispanic	1,833	14.7 ± 0.66
	Non-Hispanic other	984	7.8 ± 0.41
Education	Below high school	1,727	14.0 ± 0.49
	High school graduate	3,475	23.9 ± 0.48
	Associate/bachelor's degree	7,530	48.3 ± 0.55
	Master's degree or higher	2,284	13.9 ± 0.36
Marital status	Married	7,519	64.3 ± 0.48
Living with partner together as an unmarried couple	Yes	596	5.3 ± 0.25
	Neither	6,373	30.3 ± 0.47
Income from wages	Yes	9,924	76.5 ± 0.44
	No	4,410	23.5 ± 0.44
Ratio of income-to-poverty	Income below poverty line	1,504	8.7 ± 0.34
	Income above poverty line	13,588	91.3 ± 0.34
Region	Northeast	2,376	17.9 ± 0.55
	Midwest	3,347	20.8 ± 0.54
	South	5,656	38.3 ± 0.76
	West	3,713	23.0 ± 0.62
U.S. citizen	Yes	13,725	92.6 ± 0.39
	No	749	7.4 ± 0.39
Ever smoked 100 cigarettes or more	Yes	6,127	40.5 ± 0.53
	No	8,439	59.5 ± 0.53
Transportation-delayed care	Yes	948	6.1 ± 0.31
	No	13,468	93.9 ± 0.31
BMI	Underweight	180	1.1 ± 0.10
	Healthy	3,820	25.0 ± 0.43
	Overweight	5,394	37.1 ± 0.47
	Obese	5,348	36.8 ± 0.49
Difficulty with social activity	None	13,511	90.5 ± 0.28
	Some	946	5.7 ± 0.22
	A lot	409	2.5 ± 0.14
	Cannot do	215	1.3 ± 0.10
Care place	Yes	14,065	93.7 ± 0.26
	No	908	6.3 ± 0.26
Insurance	Yes	14,384	94.8 ± 0.24
	No	695	5.2 ± 0.24
Worry about paying medical bills	Very worried	1,918	14.2 ± 0.39
	Somewhat worried	4,371	29.9 ± 0.47
	Not at all worried	8,714	55.9 ± 0.54
Delayed medical care due to cost	Yes	932	6.6 ± 0.27
	No	14,026	93.4 ± 0.27

Note. UF: Unweighted frequency; W: Weighted; SE: Standard error; & Some variables' frequency may be lower than the total sample size due to missing data

RESULTS

Table 1 presents characteristics of the 15,092 survey participants included in this study. The weighted proportion of the participants who were up to date with recommended screening, based on the USPSTF 2021 guidelines, was 68.2%. The sample was balanced by sex, with 51.4% females. An

almost equal proportion of participants were in the 56-64 years (31.5%) and the 65-75 years (31.3%) age groups. Two-thirds of the participants were Non-Hispanic White, 11.4% were non-Hispanic Black, 14.7% were Hispanic, and the remaining 7.8% belonged to other races. Regarding educational attainment, 14.0% of the participants had less than a high school education, 23.9% were high school graduates, nearly half (48.3%) had an associate or bachelor's degree, and 13.9% held a master's degree or higher. Most survey participants were married (64.3%), and 76.5% reported income from wages. A large majority (91.3%) had income above the poverty line. Regional distribution was highest in the South (38.3%), followed by West (23.0%), Midwest (20.8%), and Northeast (17.9%). Most respondents were U.S. citizens (92.6%).

Regarding health behavior and access to healthcare, 40.5% smoked 100 cigarettes or more. Only 6.1% experienced transportation-delayed care. Of the total participants, 37.1% were overweight and 36.8% were obese. Most of the participants reported no difficulty with social activity (90.5%), had a regular place of care (93.7%), and insurance coverage (94.8%). Regarding financial concerns, 14.2% were very worried and 29.9% were somewhat anxious about paying medical bills. While the majority (93.4%) did not report a delay in receiving medical care due to cost, the remaining 6.6% reported such delays.

Results from bivariate analysis studying the association between up-to-date screening and sample characteristics are presented in **Table 2**.

Table 2. Association between up-to-date screening and respondent characteristics

Variables	Up-to-date screening		No up-to-date screening		p
	N	W % ± SE	N	W % ± SE	
Sex					0.001
Male	4,851	66.7 ± 0.7	2,152	33.3 ± 0.7	
Female	5,886	69.6 ± 0.7	2,201	30.4 ± 0.7	
Age (years)					< 0.001
45-49	745	38.3 ± 1.3	1,203	61.7 ± 1.3	
50-55	1,570	59.2 ± 1.1	1,044	40.8 ± 1.1	
56-64	3,444	74.7 ± 0.8	1,125	25.3 ± 0.8	
65-75	4,978	83.2 ± 0.6	983	16.8 ± 0.6	
Race					< 0.001
Non-Hispanic White	7,827	72.1 ± 0.5	2,687	27.9 ± 0.5	
Non-Hispanic Black	1,217	67.2 ± 1.4	544	32.8 ± 1.4	
Hispanic	1,070	55.2 ± 1.6	763	44.8 ± 1.6	
Non-Hispanic other	623	60.8 ± 1.9	361	39.2 ± 1.9	
Education					< 0.001
Below high school	989	54.9 ± 1.5	738	45.1 ± 1.5	
High school graduate	2,319	64.1 ± 1.0	1,156	35.9 ± 1.0	
Associate/bachelor's degree	5,595	72.1 ± 0.6	1,935	27.9 ± 0.6	
Master's degree or higher	1,800	76.1 ± 1.1	484	23.9 ± 1.1	
Marital status					< 0.001
Married	5,608	71.7 ± 0.6	1,911	28.3 ± 0.6	
Living with partner together as an unmarried couple	384	60.5 ± 2.1	212	39.5 ± 2.1	
Neither	4,503	66.4 ± 0.8	1,870	33.6 ± 0.8	
Income from wages					< 0.001
Yes	6,841	66.7 ± 0.6	3,083	33.3 ± 0.6	
No	3,538	78.5 ± 0.8	872	21.5 ± 0.8	

Table 2 (Continued). Association between up-to-date screening and respondent characteristics

Variables	Up-to-date screening		No up-to-date screening		p
	N	W % ± SE	N	W % ± SE	
Ratio of income-to-poverty					< 0.001
Income below poverty line	908	55.1 ± 1.6	596	44.9 ± 1.6	
Income above poverty line	9,829	69.4 ± 0.5	3,759	30.6 ± 0.5	
Region					0.011
Northeast	1,758	71.1 ± 1.2	618	28.9 ± 1.2	
Midwest	2,404	68.6 ± 1.0	943	31.4 ± 1.0	
South	3,914	66.4 ± 0.8	1,742	33.6 ± 0.8	
West	2,661	68.4 ± 1.1	1,052	31.6 ± 1.1	
U.S. citizen					< 0.001
Yes	10,181	71.9 ± 0.5	3,544	28.1 ± 0.5	
No	309	39.2 ± 2.2	440	60.8 ± 2.2	
Ever smoked 100 cigarettes or more					0.947
Yes	4,431	69.5 ± 0.7	1,696	30.5 ± 0.7	
No	6,112	69.4 ± 0.6	2,327	30.6 ± 0.6	
Transportation delayed care					< 0.001
Yes	621	61.6 ± 2.0	327	38.4 ± 2.0	
No	9,824	70.0 ± 0.5	3,644	30.0 ± 0.5	
BMI					0.232
Underweight	117	59.9 ± 4.4	63	40.1 ± 4.4	
Healthy	2,716	68.4 ± 0.9	1,104	31.6 ± 0.9	
Overweight	3,865	69.0 ± 0.8	1,529	31.0 ± 0.8	
Obese	3,836	68.3 ± 0.8	1,512	31.7 ± 0.8	
Difficulty with social activity					0.963
None	9,625	68.1 ± 0.5	3,886	31.9 ± 0.5	
Some	670	68.8 ± 1.7	276	31.2 ± 1.7	
A lot	281	67.5 ± 2.7	128	32.5 ± 2.7	
Cannot do	154	69.3 ± 3.7	61	30.7 ± 3.7	
Care place					< 0.001
Yes	10,438	71.4 ± 0.5	3,627	28.6 ± 0.5	
No	294	28.6 ± 1.7	614	71.4 ± 1.7	
Insurance					< 0.001
Yes	10,523	70.3 ± 0.5	3,861	29.7 ± 0.5	
No	208	28.8 ± 2.2	487	71.2 ± 2.2	
Worry about paying medical bills					< 0.001
Very worried	1,154	57.5 ± 1.4	764	42.5 ± 1.4	
Somewhat worried	3,054	66.9 ± 0.9	1,317	33.1 ± 0.9	
Not at all worried	6,507	72.0 ± 0.6	2,207	28.0 ± 0.6	
Delayed medical care due to cost					< 0.001
Yes	520	54.3 ± 2.0	412	45.7 ± 2.0	
No	10,214	69.8 ± 0.5	3,812	30.2 ± 0.5	

Note. W: Weighted & SE: Standard error

It may be observed that sex, age (years), race, education, marital status, income from wages, ratio of income-to-poverty, region, U.S. citizenship status, transportation delayed care, having a care place, insurance, worry about paying medical bills, and delayed medical care due to cost were associated with up-to-date screening status at the 0.05 level of significance.

Variables that had a statistically significant association with up-to-date screening in the bivariate analysis were considered for inclusion in the multivariable logistic regression model. Although variables such as, ever smoked 100 cigarettes or more, BMI, and difficulty with social activity were not statistically significant, they were retained in the multivariable model due to their established relevance in prior studies and alignment with Andersen's behavioral model that emphasizes need-based factors. **Figure 1** and **Appendix B** present results from the multivariable logistic regression model and allow

identification of the factors associated with up-to-date screening.

Adjusting for the effects of all other variables, sex had a role in remaining up-to-date with the recommended screening. Females had slightly higher odds (AOR: 1.11, 95% CI: 1.00-1.22) of being up-to-date with recommended screening compared to males. Individuals aged 50-55 years had greater odds (AOR: 2.43, 95% CI: 2.08-2.84) of being up-to-date compared to individuals aged 45-49 years. The odds further increased for those in the higher age groups: individuals aged 56-64 years had over five times higher odds (AOR: 5.34, 95% CI: 4.61-6.20) and those aged 65-75 years had over seven times higher odds (AOR: 7.79, 95% CI: 6.68-9.07) for being up-to-date compared to the 45-49 years age group. Regarding race, those belonging to the 'non-Hispanic other' category had reduced odds (AOR: 0.73, 95% CI: 0.60-0.90) for being up-to-date compared to non-Hispanic White individuals. Educational attainment appeared as a protective factor: compared to those who had below high school education, individuals with associate or bachelor's degree (AOR: 1.57, 95% CI: 1.32-1.86) and master's degree or higher (AOR: 2.19, 95% CI: 1.76-2.73) had increased odds of being up-to-date with the recommended screenings. Those who were married (AOR: 1.35, 95% CI: 1.22-1.50) and lived with a partner as an unmarried couple (AOR: 1.26, 95% CI: 1.00-1.57) had higher odds for being up-to-date compared to those who were unmarried and not living with a partner. Those who earned income from wages had reduced odds (AOR: 0.81, 95% CI: 0.71-0.93) but participants with income above poverty line had higher odds (AOR: 1.41, 95% CI: 1.16-1.72) for being up-to-date.

Participants' region of residence played a role: those belonging to the Midwest (AOR: 0.79, 95% CI: 0.67-0.93) and South (AOR: 0.80, 95% CI: 0.69-0.93) had lower odds of being up-to-date compared to those belonging to the Northeast region. Odds of being up-to-date reduced by almost half (AOR: 0.52, 95% CI: 0.41-0.66) among those who were not US citizens compared to U.S. citizens. Participants' BMI was positively associated with being up-to-date on screening. Compared to participants in the underweight category, those in the healthy (AOR: 1.59, 95% CI: 1.05-2.40), overweight (AOR: 1.73, 95% CI: 1.14-2.62), and obese (AOR: 1.76, 95% CI: 1.17-2.66) categories were significantly more likely to be up to date.

Healthcare access factors were among the strongest predictors of being up-to-date. Having a usual place of care was associated with more than a fourfold increase in odds (AOR: 4.43, 95% CI: 3.61-5.43) of being up-to-date, and having insurance was associated with 2.54 times higher odds (AOR: 2.54, 95% CI: 1.97-3.28) compared to those not having such access. Those who were worried about paying medical bills and experienced a delay in medical care due to the cost involved had lower odds of being up-to-date with the recommended screening. Still, the results did not achieve statistical significance.

DISCUSSION

This study aimed to identify factors associated with CRC screening among U.S. adults aged 45 to 75 using data from the 2023 NHIS. Approximately 68.2% of participants reported being screened for CRC. The CRC screening is influenced by a complex interplay of predisposing, enabling, and need-based factors, as outlined in Andersen's behavioral model [15]. In the

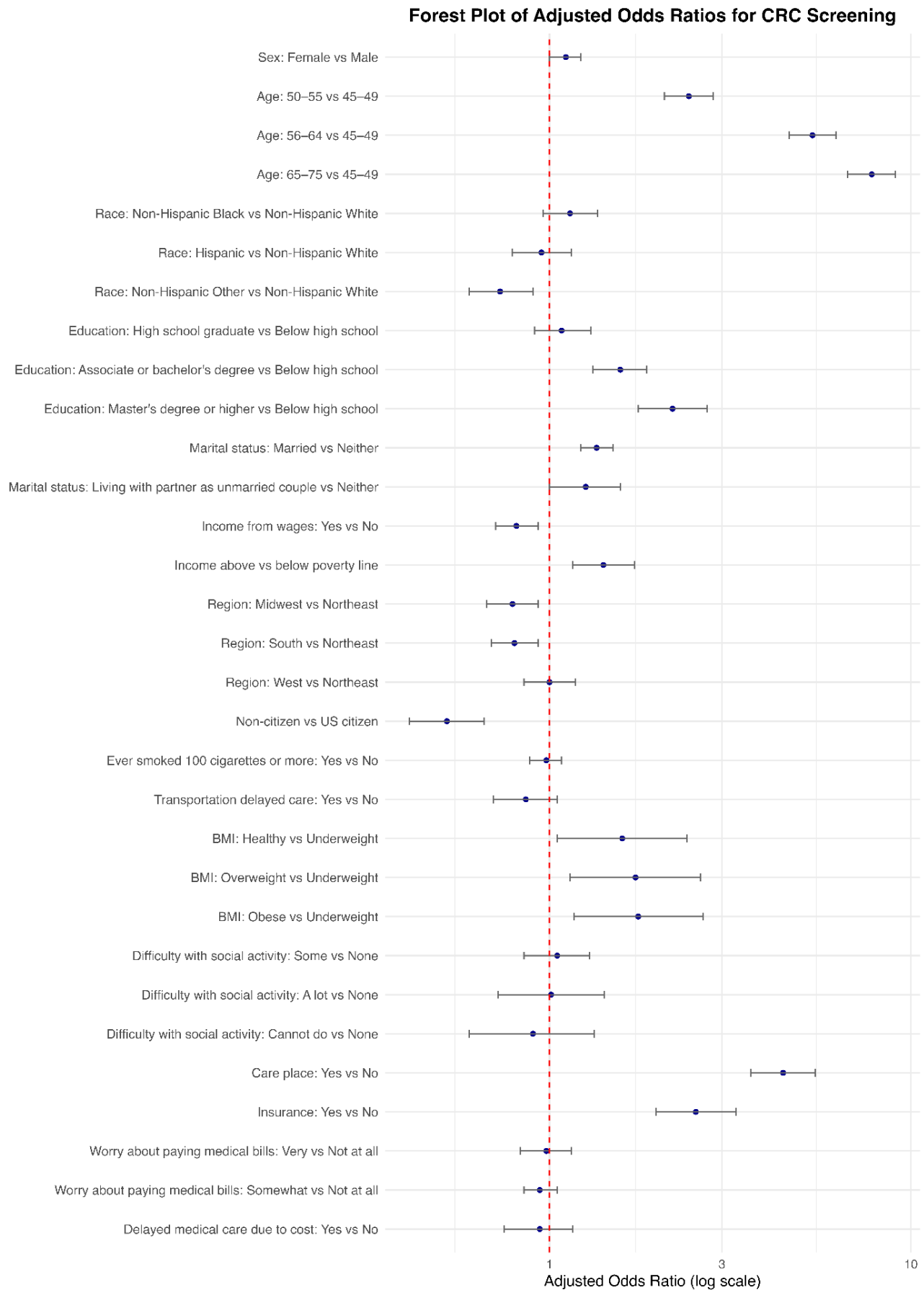


Figure 1. AOR and 95% CIs for factors associated with up-to-date screening (CIs that include the vertical dashed line at AOR = 1.0 indicates no statistically significant association) (Source: Authors' own elaboration)

following paragraphs, we compare our findings with the existing literature, highlight public health and clinical implications, and recommend strategies to enhance screening rates.

Predisposing Factors (Demographics)

Our study found significant differences in CRC screening between men and women, where women had higher odds of being up-to-date with the screening. There is conflicting evidence concerning sex adherence to cancer screening in the literature. For instance, the study in [16] interviewed 1,552 female and 586 male black medicare beneficiaries in Baltimore, MD, to evaluate self-reported CRC screening behaviors from November 2006 to March 2010. The study found that males were significantly less likely than females to report being up-to-date with screenings (77.5% compared to 81.6%, $p = 0.030$). Studying 345 male and female veterans in 2006 in Minneapolis, MN, to examine CRC screening adherence rates by gender using medical records and self-report, the study in [17] found a significantly higher rate of CRC screening among men when using self-report data, but no significant differences in either overall or test-specific screening adherence when using medical record data. More studies are needed to clarify the association between sex and CRC screening.

Consistent with prior research, age was one of the strongest predictors of CRC screening. The screening prevalence significantly increased with age in our sample, with the younger age group (45-49 years) showing the lowest uptake, compared to over 80% among those aged 65-75. This age-related disparity underscores the progress made in screening older adults and the pressing need to increase awareness and uptake among newly eligible individuals. The recent expansion of CRC screening guidelines to begin at age 45 poses implementation challenges, as younger adults may be less aware of the recommendations or perceive lower risk, and providers may continue to prioritize older age groups. Without tailored efforts such as provider prompts and facilitating convenient screening methods (e.g., mailed stool tests), the expanded guidelines may inadvertently widen screening disparities. Raising awareness among both clinicians and the public about the updated starting age is critical for improving uptake in the younger cohort [18].

In contrast, race and ethnicity have emerged as significant predisposing factors associated with disparities in CRC screening. Non-Hispanic White adults had the highest rates of CRC screening, while minority groups, especially Hispanic, non-Hispanic Black, and non-Hispanic other, demonstrated significantly lower screening rates. The ethnic and racial disparities in CRC screening are well-documented in the literature [19]. National survey data indicate that as of 2021, CRC screening prevalence was highest among White adults (approximately 78% up-to-date) compared to around 73% among Black adults, roughly 69% of screening rates among Hispanic adults, and only about 64% among Asian adults [19]. Our findings mirrored these disparities as well as some narrowing of the Black-White gap reported in recent years [20]. Previous studies attribute these disparities to various barriers that disproportionately affect minority communities, including language and health literacy issues, lower rates of provider recommendations, cultural beliefs, and medical mistrust [21]. A qualitative study found that limited awareness of CRC, poor patient-provider communication, and distrust in the healthcare system contribute to lower screening uptake

among Hispanic and Asian Americans [22]. Our results reinforce the need to address these disparities in minority communities. Trained community education and trust-building measures are essential to improving screening among racial and ethnic minority groups.

Enabling Factors (Access and Resources)

Enabling resources significantly impacted CRC screening in this study. Health insurance status and having a usual source of care were significantly associated with CRC screening. Being uninsured was linked to significantly lower odds of being screened. This finding aligns with extensive evidence in the literature [19, 20]. Using NHIS data in the USA to examine cancer screening disparities by race/ethnicity and insurance groups in the USA in 2018, it was found that uninsured adults had CRC screening rates as low as 18-30%, compared to nearly 60-70% in insured adults [20]. The study in [19] used 2021 NHIS data to estimate proportions of adults up to date with USPSTF recommendations for breast (women aged 50-74 years), cervical (women aged 21-65 years), and CRC screening (adults aged 50-75 years) across sociodemographic and health care access variables in 2022. They found that estimates were below 50% among those without a wellness check in 3 years across all screening types, among those without a usual source of care or insurance (aged < 65 years) for breast and CRC screening, compared to approximately 72% of those with regular care [19]. Having a usual primary care provider facilitates referrals and reminders for screening; therefore, participants in our study with a usual source of care were significantly more likely to have been screened than those without. This pronounced difference (around a 20-30 percentage point gap) underscores how enabling access factors directly translate into utilization [19].

Citizenship status also emerged as a significant predictor of CRC screening adherence. Non-U.S. citizens had nearly 50% lower odds of being up-to-date with screening compared to U.S. citizens. This disparity likely reflects structural barriers, such as limited eligibility for public insurance programs and reduced health system engagement among non-citizens. Immigrant populations may also face reduced access to preventive care due to a lack of culturally tailored outreach or misinformation regarding screening eligibility. These findings align with previous studies documenting lower access to routine health care among immigrants, particularly non-U.S. citizens [23, 24]. This highlights the need for inclusive public health strategies that actively engage non-citizen populations, including expanded access to preventive care services.

Socioeconomic resources further stratified screening uptake. Higher income and education, classic enabling resources in Andersen's framework, were strongly associated with a greater likelihood of completing CRC screening. Individuals of lower socioeconomic status had lower CRC screening rates. This finding aligns with national trends: in 2021, only about 58% of adults without a high school diploma were up-to-date, compared to 84% of those with a college degree [19]. Similarly, CRC screening prevalence increases from approximately 65-67% in the lowest income bracket to over 80% in the highest income group [19]. These disparities reflect variations in health literacy, healthcare navigation, and financial capability to access preventive services. Although screening colonoscopy and stool tests are covered as preventive services under the affordable care act, indirect costs (such as time off work and transportation) and competing life

priorities can disproportionately hinder lower-income individuals. Support systems such as paid sick leave, patient navigation, and community outreach may be essential to enhance screening among socioeconomically disadvantaged groups.

Family and social support were also significant. Marriage (having a partner) promotes health service use through support and encouragement. In our study, married individuals had higher CRC screening uptake than those who were unmarried, echoing prior findings that marital status, along with age, education, and income, influence CRC screening [25]. Spouses may motivate each other to attend preventive health appointments, and married individuals might enjoy excellent social support to overcome barriers (for instance, assistance during colonoscopy or encouragement to complete an at-home stool test). Recognizing the influence of such social enabling factors implies that interventions involving family members (e.g., spousal reminders or educational campaigns targeting couples) could be beneficial.

Need-Based Factors (Health Status and Perceived Need)

BMI showed relatively weak associations with screening in our data. We did not find strong evidence that obesity was a barrier to CRC screening after controlling other factors. This aligns with a 2012 systematic review that found no overall association between BMI and colon cancer screening rates [26]. However, prior studies have noted that specific subgroups of obese individuals, particularly obese White women, have lower screening uptake than their normal-weight counterparts [26]. Possible explanations include weight-related stigma or avoidance of medical care among some obese patients, as well as clinicians sometimes prioritizing preventive counseling for patients with complex health issues. Thus, while need factors, such as a higher underlying risk of CRC (due to obesity or family history), might logically increase one's likelihood of screening, in practice, these effects are intertwined with whether the person engages with the healthcare system.

Implications for Public Health and Clinical Practice

These findings have significant implications for public health and clinical practice. First, the strong influence of enabling factors such as insurance and having a usual source of care indicates that expanding healthcare access must be a cornerstone of increasing CRC screening rates. Policies that expand coverage and reduce cost barriers can directly affect screening uptake. For instance, the affordable care act's mandate for insurers to cover preventive screenings without cost sharing has improved cancer screening utilization over the past decade [20]. More recently, states that expanded medicaid (providing coverage to more low-income adults) have seen higher CRC screening rates among underserved populations. A 2023 analysis of federally qualified health centers found a median screening rate of 42.1% in medicaid expansion states compared to 36.5% in non-expansion states [27]. Ensuring that every adult aged 45 to 75 years of age either has health insurance or can access free screening programs is fundamental. In practical terms, public health agencies might expand free screening initiatives (such as fecal test mailing programs or subsidized colonoscopies) for those who remain uninsured to approximate access for the insured individuals.

Second, our results highlight the importance of healthcare providers' engagement and recommendations. For instance, having a regular provider increases the likelihood that a

clinician will recommend screening, and patients who feel less need (e.g., asymptomatic 45-year-olds) might be encouraged by a physician's advice to get screened. Physician recommendation is one of the strongest predictors of CRC screening adherence [28]. Clinicians, especially in primary care, should actively recommend CRC screening to all eligible patients, paying particular attention to those who might otherwise slip through the cracks, such as younger patients, minorities, and those with few health complaints.

Third, targeted interventions at the community level are essential to reach populations with persistently low screening rates. Public health programs should incorporate evidence-based strategies to address barriers faced by these groups. One proven approach is patient navigation, which assists individuals in overcoming logistical hurdles such as scheduling, preparation, and fear of the procedure. Studies indicate that patient navigation significantly enhances CRC screening completion, especially within minority and low-income populations [29]. Similarly, mailing stool-based testing kits to patients' homes and reminder calls or texts has proven highly effective in increasing screening uptake [29]. Multi-component interventions that combine education, convenient screening options, and navigation support produce the best results. Public health leaders should adopt these strategies in communities where screening is lagging.

Finally, expanding CRC screening recommendations to include adults aged 45-49 years has resource implications that must be addressed. Our data and other studies indicate that the younger segment of the eligible population is not yet being effectively reached [30]. Healthcare systems, particularly those serving disadvantaged patients, may be stretched by the increased demand for screening. Therefore, policymakers and health systems must allocate resources appropriately; for example, by funding additional endoscopy capacity or stool testing programs and ensuring that community health centers receive support to manage the influx of newly eligible patients [30].

Limitations of the Study

This study has some limitations. It relies on self-reported data from the NHIS, which is subject to recall and social desirability bias. Participants may overreport their adherence to CRC screening guidelines, potentially inflating true screening rates. Additionally, specific screening modalities and timing may be inaccurately reported, affecting the classification of up-to-date status. As with every survey data, there is a potential for non-response bias. Excluding native American, Pacific Islander, and multiracial populations may bias estimates, as these groups experience disproportionate mental health burdens due to historical trauma and systemic marginalization. Future studies should employ oversampling or mixed-methods approaches to capture their experiences. Nonetheless, the use of survey design features including weights may have corrected such bias in the study results. Furthermore, the cross-sectional design limits causal inference. While associations can be identified between sociodemographic factors and screening uptake, the temporal sequence between exposure and outcome cannot be established. Future longitudinal studies are needed to assess the impact of interventions and policy changes on CRC screening behavior over time.

CONCLUSIONS AND CALL TO ACTION

In summary, this study found that CRC screening uptake in U.S. adults aged 45 to 75 is significantly influenced by predisposing factors such as age and race/ethnicity; enabling factors such as insurance, income, and access to healthcare; and need-based factors including health perceptions. Our discussion illustrates that these findings are consistent with Andersen's Behavioral Model and align with the extensive literature on cancer screening disparities. Importantly, we identified persistent gaps in screening among certain underserved or disadvantaged groups, particularly the uninsured, those lacking regular care, and racial/ethnic minority populations. These disparities have profound implications for public health. CRC is largely preventable and treatable when caught early; inequitable screening leads to avoidable suffering, and mortality will continue to burden disadvantaged communities.

Closing the CRC screening gap requires coordinated action from public health agencies, clinicians, and policymakers. We issue a call to prioritize and implement strategies ensuring that all eligible adults, regardless of race, socioeconomic status, or geography, can access and complete colorectal screenings. Public health officials should establish robust programs to reach populations with low uptake, using proven interventions (mailed FIT/FOBT kits, patient navigation, community education) to reduce barriers [29]. Clinicians in primary care must advocate CRC screening, recommending it at every opportunity and following up to help patients overcome hesitancy or obstacles. Healthcare systems and payers should support these efforts by enabling outreach and removing cost barriers; for example, by fully covering stool tests and minimizing out-of-pocket expenses for colonoscopy. Policymakers at the state and federal levels should continue to expand insurance coverage and consider policies such as Medicaid expansion, which has demonstrably improved screening in low-income groups [27]. Additionally, it is imperative to invest in community health centers and safety-net providers to ensure they can deliver screening to those newly eligible at age 45 and other high-need patients (the revised CRC screening guideline and screening burden at community health centers [30]).

The public health goal ahead is clear: to increase the national CRC screening rate toward the healthy people 2030 target of 72.8% (or higher) [31], while eliminating the inequities that leave some groups behind. As of 2023, approximately one-third of Americans aged 45 to 75 are not current with screening [31], a proportion that is even greater in particular minority and low-resource populations. Achieving equity in screening requires culturally sensitive and community-driven approaches to engage those who have been historically underserved. Every stakeholder plays a role in this process. By acting on these findings—enhancing access, bolstering provider recommendations, and implementing targeted interventions—we can make meaningful progress toward ensuring that all adults benefit from the life-saving potential of CRC screening. Ultimately, addressing these screening disparities is both an ethical and practical strategy to reduce preventable CRC deaths. We call on health leaders and practitioners to heed this evidence and intensify efforts to improve CRC screening uptake in every population segment, with a particular focus on those most in need.

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APPENDIX A

Table A1. USPSTF-recommended colorectal cancer screening modalities and intervals

Screening Modality	Recommended Interval
High-sensitivity guaiac fecal occult blood test (HSgFOBT)	Annually
Fecal immunochemical test (FIT)	Annually
Stool DNA-FIT (sDNA-FIT)	Every 1-3 years
Computed tomography (CT) colonography	Every 5 years
Flexible sigmoidoscopy	Every 5 years
Colonoscopy	Every 10 years
Flexible sigmoidoscopy + FIT	Sigmoidoscopy every 10 years and FIT annually
Cologuard test	Not exceeding 3 years

APPENDIX B

Table B1. Results from multivariable logistic regression to study factors associated with up-to-date screening

Variables		AOR	95% CI	
			Lower bound	Upper bound
Sex	Male	1		
	Female	1.11	1.00	1.22
Age (years)	45-49	1		
	50-55	2.43	2.08	2.84
	56-64	5.34	4.61	6.20
	65-75	7.79	6.68	9.07
Race	Non-Hispanic White	1		
	Non-Hispanic Black	1.14	0.96	1.36
	Hispanic	0.95	0.79	1.15
	Non-Hispanic other	0.73	0.60	0.90
Education	Below high school	1		
	High school graduate	1.08	0.91	1.30
	Associate/bachelor's degree	1.57	1.32	1.86
	Master's degree or higher	2.19	1.76	2.73
Marital status	Married	1.35	1.22	1.50
	Living with partner together as an unmarried couple	1.26	1.00	1.57
	Neither	1		
Income from wages	Yes	0.81	0.71	0.93
	No	1		
Ratio of income-to-poverty	Income below poverty line	1		
	Income above poverty line	1.41	1.16	1.72
Region	Northeast	1		
	Midwest	0.79	0.67	0.93
	South	0.80	0.69	0.93
	West	1.00	0.85	1.18
U.S. citizen	Yes	1		
	No	0.52	0.41	0.66
Ever smoked 100 cigarettes or more	Yes	0.98	0.88	1.08
	No	1		
Transportation delayed care	Yes	0.86	0.70	1.05
	No	1		
BMI	Underweight	1		
	Healthy	1.59	1.05	2.40
	Overweight	1.73	1.14	2.62
	Obese	1.76	1.17	2.66
Difficulty with social activity	None	1		
	Some	1.05	0.85	1.29
	A lot	1.01	0.72	1.42
	Cannot do	0.90	0.60	1.33
Care place	Yes	4.43	3.61	5.43
	No	1		
Insurance	Yes	2.54	1.97	3.28
	No	1		
Worry about paying medical bills	Very worried	0.98	0.83	1.15
	Somewhat worried	0.94	0.85	1.05
	Not at all worried	1		
Delayed medical care due to cost	Yes	0.94	0.75	1.16
	No	1		