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Correlates of colorectal cancer screening among residents of Ohio Appalachia

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Abstract

There is an excess burden of colorectal cancer (CRC) in the Appalachian region of the U.S., which could be reduced by increased uptake of CRC screening tests. Thus, we examined correlates of screening among Appalachian residents at average-risk for CRC. Using a population-based sample, we conducted interviews with and obtained medical records of Appalachian Ohio residents 50–75 years between September 2009 and April 2010. Using multivariable logistic regression, we identified correlates of being within CRC screening guidelines by medical records. About half of participants were within CRC screening guidelines. Participants who were older (OR=1.04, 95% CI: 1.01, 1.07), had higher income ($30,000–$60,000, OR=1.92, 95% CI: 1.29, 2.86; ≥$60,000, OR=1.80, 95% CI: 1.19, 2.72), a primary care provider (OR=4.22, 95% CI: 1.33, 13.39), a recent check-up (OR=2.37, 95% CI: 1.12, 4.99), had been encouraged to be screened (OR=1.57, 95% CI: 1.11, 2.22), had been recommended by their doctor to be screened (OR=6.68, 95% CI: 3.87, 11.52), or asked their doctor to order a screening test (OR=2.24, 95% CI: 1.36, 3.69) had higher odds of being screened within guidelines in multivariable analysis. Findings suggest that access to and utilization of healthcare services, social influence, and patient-provider communication were the major factors associated with CRC screening. Researchers and healthcare providers should develop and implement strategies targeting these barriers/facilitators to improve CRC screening rates and reduce the CRC burden among residents of Appalachia.

Keywords

colorectal cancer; screening; Appalachia; health disparities

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Introduction

Colorectal cancer (CRC) is the third most commonly diagnosed cancer and the second leading cause of cancer mortality among men and women in the United States (U.S.) [1, 2], with most individuals having a lifetime risk of approximately 5% [3]. In 2013, it is estimated that 142,820 men and women will be diagnosed with colorectal cancer, and an estimated 50,830 will die from this disease [4]. CRC incidence and mortality rates vary by age, gender, race/ethnicity, and geographic location [5]. One such population that specifically has an excess burden of CRC is residents of Ohio Appalachia. Rates of CRC incidence and mortality are 12% and 8.1% higher, respectively, among residents of Appalachian Ohio compared to adults living in non-Appalachian Ohio [6].

Since CRC usually develops slowly over a period of time, the U.S. Preventive Services Task Force (USPSTF) currently recommends CRC screening by fecal occult blood test (FOBT) annually, sigmoidoscopy every 5 years, or colonoscopy every 10 years among average-risk adults aged 50–75 years [7]. The goal of recommended CRC screening is to reduce CRC mortality through prevention or early detection (*i.e.*, removal of benign precursor lesions and/or diagnosis at an earlier stage when the disease is more easily treated) [5]. In the U.S., the prevalence of CRC screening within-recommended-guidelines has increased in the past decades [8], but generally there has not been widespread adoption of CRC screening and there are disparities in screening rates among minority and low-income populations [9, 10].

Reasons for the low uptake of CRC screening include numerous factors at the patient, provider, and system levels [11–18]. Patient factors include but are not limited to lack of knowledge, lack of provider recommendation, perception of risk (high or low), cost and/or lack of health insurance, embarrassment, aversion, inconvenience (time and location), test preparation requirements, lack of symptoms, perceived discomfort or pain, and fear. Health care provider factors include time constraints, patient refusal, and lack of agreement with recommended guidelines. System level factors contributing to lower CRC screening rates include not using a reminder system and the lack of policies at the level of the health center and society.

Studies have also shown that race, age, gender, education, socioeconomic (SES) factors (e.g., lack of health insurance), and lifestyle factors including the lack of using other preventive services are associated with lower CRC screening rates [8, 10, 16, 19–24]. Additionally, data suggest that residence in rural areas (compared to urban or suburban) may also be an important barrier to CRC screening, as rural residents are less likely to report having a usual source of care, are less likely to utilize preventive services, and have transportation problems [6, 25–31].

Many of the above listed characteristics and barriers to screening are descriptive of the residents living in Appalachia Ohio and these factors contribute to the documented CRC disparities among this population. Previous investigations have assessed CRC screening patterns among Appalachian populations and many of these studies have documented lower CRC screening rates, with reported rates as low as 32% [24, 25, 27–29, 32]. Since CRC screening rates are low and there is an increase in CRC mortality rates among residents of Appalachia Ohio, innovative strategies are needed to increase CRC screening rates. The first step in developing and implementing community-based strategies to increase CRC screening rates among average-risk adults living in rural Appalachia Ohio is to gain insight into the current factors that may be contributing to the documented CRC disparities. To complete this task, we conducted a cross-sectional telephone survey study prior to initiating a CRC screening intervention study. The focus of this paper is to describe current CRC screening behaviors and screening-related barriers to provide insight into the behavioral motivations of this population that may be used the development of community-based interventions.

Methods

Research Design

Twelve counties in Appalachian Ohio were identified based on higher than average percent of CRC cases diagnosed at late stage using data for all incident CRC cases (2000–2004) reported to the Ohio Cancer Information Surveillance System. The survey items were structured around the social determinants of health (SDH) framework [33] and included constructs measuring individual demographics, risk factors (*e.g.,* smoking), the healthcare system (*e.g.,* regular doctor, check up in past two years), patient-provider communication, and social influence. The survey was conducted between September 2009 and March 2010 to establish baseline CRC screening rates and to document prevalence of CRC screening barriers. The study was approved by the Ohio State University Institutional Review Board and written informed consent was obtained from all participants.

Recruitment and eligibility

Participants for the cross-sectional survey were identified from lists provided by a commercial vendor that were restricted to residents 51 years of age and older. First, all names listed as being between ages 51 to 99 years were selected. As more males than females were represented in these lists, a proportional sampling scheme was used to randomly select names by county to reflect the county gender proportions in the 2000 U.S. census.

Potentially eligible participants were mailed a small packet that included: a recruitment letter; a two-page informational handout introducing the survey study, indicating that someone would be calling them during the next week to conduct a short telephone survey; a consent form; a HIPAA authorization form; and answer choices for specific questions to make it easier to answer questions during the telephone interview.

Trained interviewers were provided with a list of potential participants and up to ten calls were made to establish contact with each individual. Contact attempts were made on weekdays and weekends and at various times (morning, afternoon, early evening) to maximize chances of reaching an individual. If a person was not reached, a standard message was left on the answering machine (if available). If after ten attempts an individual could not be contacted, they were sent a no contact letter that included a toll-free number. If a potential participant contacted the study office within two weeks after sending the no contact letter, the standard study process was followed.

Once a potential participant was reached, the study was explained in more detail using a standard script. Permission to verify eligibility was obtained and eligibility was determined by administering a short screening questionnaire. Eligibility criteria for study participation included: ages 51 to 75 years, inclusive; ability to read and speak English without assistance; ability to provide informed consent; resident of one of the 12 study counties (not residing in a nursing home or other institution); a working home telephone number; no prior history of CRC, familial/hereditary cancer syndrome (*e.g.,* hereditary non-polyposis CRC), polyps, or inflammatory bowel disease (*e.g.,* Crohn’s disease); in good health (*i.e.,* no contraindications to CRC screening); and if female, not pregnant.

The goal was to have at least 90 participants in each county. To accomplish this goal, 6,420 names were randomly selected from the list of residents. Of these, 1,985 (30.9%) were ineligible or deceased and 1,262 (19.7%) could not be contacted via telephone or mail.

Among the remaining 3,173 potentially eligible and contacted individuals, 2,067 (65.1%) refused participation and 1,106 (34.9%) completed the survey (an average of 92 per county).

Data collection

The baseline telephone interview was administered by a trained interviewer and was completed in approximately 15–20 minutes. After completing the telephone survey, participants were sent a $10 gift card in appreciation of their time and a medical release form with a stamped, addressed envelope to sign and return, giving study staff permission to contact their physicians to confirm receipt of self-reported CRC screening tests. If the medical release form was not returned, the participant was re-contacted by the interviewer and a second form was mailed to the participant (if necessary). Once signed medical release forms were received, physicians' offices were contacted to request information about participants' CRC screening. This process took place over a four-month period immediately following the conclusion of the baseline survey period. Data capture for the medical record review was conducted using REDCap electronic data capture tools hosted at The Ohio State University [34].

Measures

Outcome variable: CRC screening behavior—The outcome of interest was whether men and women were within CRC screening guidelines recommended by the USPSTF [7]. To access CRC screening behavior, participants were first asked if they had ever completed a particular CRC screening test, and if they had completed the screening test, they were asked the date of their last screening test. If participants reported being screened, but were unable to provide the data of their last test, a third question was asked, which provided categorical responses about the data of their most recent screening test (*i.e.*, less than one year ago or more than one year ago). Participants were classified as being within recommended CRC screening guidelines if they had completed one of the following: 1) FOBT in the last year; 2) flexible sigmoidoscopy in the last five years; or 3) colonoscopy in the last 10 years [7].

Independent variables—Variables were selected based on their association with CRC screening behaviors.

Demographic characteristics—Participants provided information about their age, gender, race (White, Black or African American, Asian, Native Hawaiian or Pacific Islander, Native American or Alaska Native, more than one race), marital status (single/never married, married or living as married, divorced, separated, widowed), education (8th grade or less, some high school, high school graduate, some college, associate degree, college graduate, graduate or professional degree) employment status (full or part-time, unemployed or disabled, retired or volunteer), annual household income (<$10,000, $10,000–$19,999, $20,000–$29,999, $30,000–$39,999, $40,000–$49,999, $50,000–$59,999, $60,000–$69,999, ≥$70,000), and health insurance (Medicaid, Medicare, private).

Smoking status—Participants' smoking status was determined using two items [35]. First, each participant was asked "Have you smoked at least 100 cigarettes in your entire life?" with the following responses: yes/no. If a participant responded yes, they were asked a second item "Do you now smoke cigarettes every day, some days, or not at all?" Responses were: everyday; some days; not at all. Responses to these two items allowed participants to be categorized as never smokers (never smoked at least 100 cigarettes), former smokers (smoked at least 100 cigarettes, but not currently smoking), and current smokers (smoked at least 100 cigarettes and smokes on some or every day).

General health—Self-rated health status was measured by a single item on a Likert scale (poor; fair; good; very good; excellent) [36]. The responses were made into a dichotomous response with poor and fair vs. good, very good, and excellent. Medical conditions requiring the participant to have regular medical visits was documented (yes/no), and if the participant responded "Yes," the medical condition was documented.

Healthcare utilization—Participants were asked if they had a regular health care provider (yes/no), and if the participant responded "Yes," the name and location of the health care provider were documented. Participants were also asked when was the last time they underwent a regular check-up (within the last year; between 1–2 years ago; more than two years ago; did not remember).

Perceived CRC risk—Participants were asked their perceived comparative CRC risk by "Compared to other men/women your age, what do you think your risk of getting colon cancer is in your lifetime?" Response was on a 5-point scale (much lower, somewhat lower, about the same, somewhat higher, much higher) [37]. The responses were made into a dichotomous response with lack of high perceived risk (*i.e.,* much lower, somewhat lower, and about the same) vs. high perceived risk (*i.e.,* somewhat higher and much higher).

Knowledge about CRC screening—To determine knowledge about CRC screening, participants were asked for each CRC screening test (FOBT, flexible sigmoidoscopy, colonoscopy) whether they had heard of the test (yes/no); followed by the reading of a standardized definition of the CRC screening test. After each test description, participants were asked if they had heard of the test now that it was described. Participants were asked if they knew what age a healthy person should start to have CRC screening tests [38].

Patient-provider communication-CRC screening—Participants were asked: if a doctor ever asked them to complete a CRC screening test (yes/no) and if they had ever asked a doctor to order a CRC screening test (yes/no).

Social influence-CRC screening—Participants were asked if anyone (other than a doctor) had ever encouraged or discouraged them from having a CRC screening test (yes/no).

Statistical analysis

For this report, the goal was to identify factors associated with being within guidelines for CRC screening among study participants. The primary outcome, CRC screening within guidelines by medical record review, was defined as having any one of the following: 1) FOBT in the past year; 2) flexible sigmoidoscopy in the past 5 years; or 3) colonoscopy in the past 10 years. Multiple imputation was used to impute missing data on the primary outcome and income. As explained by Ibrahim et al. [39], multiple imputation provides unbiased estimates of covariate effects in regression models when the reason for missingness is related to the observed data whereas an analysis of just the complete cases may result in substantial bias. A fully conditional specification (FCS) imputation method was implemented [40]. Missing income was imputed using a discriminant function including all covariates of interest (Table 1) along with self-reported within guidelines status. Missing outcome data was imputed using a logistic regression model containing income (imputed or observed value) and all covariates included in the imputation model for income. Monotone missingness was induced by omitting participants with incomplete data for any covariate of interest (1.9% of participants). Odds ratios and confidence intervals were calculated using the data from 40 imputed datasets. Variable selection for the multivariable model used a backward selection process whereby a potential predictor was omitted based on the p-value (p <0.1 criterion) obtained by combining the estimates from the 40 imputed datasets [41]. All analyses were conducted in SAS 9.2 or 9.3 (SAS Institute, Cary, NC); PROC MI (SAS 9.3) was used to impute the data and PROC MIANALYZE (SAS 9.2) was used to combine the estimated odds ratios from the 40 imputed data sets.

Results

Participant characteristics

We report data on 1,085 (98.1%) of the 1,106 participants with complete data on all variables of interest other than income or CRC screening status by medical record review, which were imputed if missing. Participant characteristics are summarized in Table 1.The mean age of the participants was 61.4 years. Most participants were female (58.6%), white (96.8%), married or living as married (77.3%), had obtained at least some college education (56.7%), and reported having private health insurance only (52.0%). Most were never smokers (53.9%), self-rated their health as good, very good, or excellent (85.3%), reported having a regular primary care doctor (92.8%), and had a regular check-up or physical in the past two years (89.1%). Few participants perceived that they were at higher CRC risk in comparison to others their age and gender (9.7%). A majority of participants were aware of CRC screening tests and many also knew that screening should begin at age 50 years (86.6% and 54.7%, respectively). In addition, more than half of the participants reported being encouraged by someone (other than their doctor) to be screened for CRC (54.2%), and most indicated they had a doctor's recommendation for CRC screening (77.6%). About half of the participants were within CRC screening guidelines according to their medical record (49.5%).

Factors associated with CRC screening

Table 1 shows the participant characteristics that were associated with being within CRC screening guidelines by medical record review. Age was positively associated with being within CRC screening guidelines; for a 1-year increase in age, there was a 4% increase in the odds of being within guidelines (OR= 1.04, 95% CI: 1.01, 1.06). Income was also positively associated with being within CRC screening guidelines; compared to participants whose annual household income was <$30,000, those with incomes $30,000–$60,000 or > $60,000 had greater odds of having been screened (OR=2.01, 95% CI: 1.41, 2.86 and OR=1.72, 95% CI: 1.22, 2.45, respectively). Having any form of health insurance was positively associated with being within CRC screening guidelines; compared to the uninsured, those with public only, private only, or both public and private insurance had twice (OR=2.16, 95% CI: 1.06, 4.40), three times (OR=3.16, 95% CI: 1.74, 5.74) and five times (OR= 5.08, 95% CI: 2.71, 9.51) the odds of being within screening guidelines, respectively. Having a regular source of primary healthcare was positively associated with being within guidelines (OR=10.26, 95% CI: 3.51, 29.92). Having had a check-up in the past two years was also positively associated with CRC screening within guidelines (OR=5.44, 95% CI: 2.87, 10.31), as was having been encouraged by someone to be screened for CRC (OR=2.38, 95% CI: 1.78, 3.18), having a doctor's recommendation to be screened (OR=9.09, 95% CI: 5.52, 14.97), and ever asking a doctor to order a CRC screening test (OR=2.04, 95% CI: 1.34, 3.13).

Mutlivariate correlates of being within CRC screening guidelines

Table 2 shows the results from our multivariate modeling using backward selection for correlates of screening. In the multivariable model, age, income, having a primary care provider, having a check-up in the past two years, as well as being encouraged by someone to be screened, being asked to be screened by a doctor, and asking a doctor to order a screening test for CRC, were the statistically significant correlates of being within guidelines for CRC screening. A 1-year increase in age was associated with a 4% increased likelihood of being within CRC screening guidelines (OR=1.04, 95% CI: 1.01, 1.07). Participants with increasing annual household incomes had higher odds of being within screening guidelines (OR=1.92, 95% CI: 1.29, 2.86 and OR=1.80, 95% CI: 1.19, 2.72 for incomes of $30,000–$60,000 and >$60,000, respectively). Participants who had a primary care provider (OR=4.22, 95% CI: 1.33, 13.39) and those who had a check-up in the past two years (OR=2.37, 95% CI: 1.12, 4.99) had a greater odds of being within CRC screening guidelines. Moreover, those who were encouraged to be screened (OR=1.57, 95% CI: 1.11, 2.22), were asked by their doctor to be screened (OR=6.68, 95% CI: 3.87, 11.52), and who asked their doctor to order a CRC screening test (OR=2.24, 95% CI: 1.36, 3.69) had a greater odds of being within guidelines for CRC screening.

Discussion

Appalachia is a region of the U.S. where the residents have an excess burden of CRC. While screening tests for CRC have been shown to reduce both incidence of and mortality from CRC, few studies have explored factors associated with CRC screening in this population. The results of this study demonstrate that only about half of Appalachian Ohio residents over age 50, at average-risk for developing CRC, were screened within guidelines. This rate is lower than estimates from the BRFSS (65.4%) [42] and the NHIS (58.3%) [43] in 2010, for U.S. residents of the same age. Moreover, four factors, namely, demographics (including income and age), healthcare access and utilization, patient-provider communication, and social influence, which are important constructs of the SDH framework, emerged as important correlates of CRC screening within guidelines for this specific population.

Income, as a measure of SES, which is related to “access” to healthcare, was positively associated with within-guideline CRC screening, as previously reported [44]. Earning a higher income increases an individual’s likelihood of having health insurance, which would then increase their ability to access healthcare. In line with this, we found that those who had access to healthcare, by reporting having a regular primary care provider, were also more likely to be screened. Similarly, data from the early NHIS surveys [8–10, 23] and the 2010 survey demonstrated higher CRC screening test use among individuals reporting higher incomes, as well as those with a usual source of health care. In addition to SES, we found that age was also a significant predictor of being within screening guidelines. In support of this, other studies have found that older participants, perhaps due to Medicare coverage or being retired and having more time to complete a test, had higher CRC screening rates [9, 10, 20, 23]. In this study, some demographic factors were not, however, found to be associated with being within guidelines for CRC screening, as other studies have reported. For example, in other studies [9, 20] it has been shown that men are more likely to be within CRC screening guidelines; however, our study did not find any differences by gender. Moreover, educational status did not predict being within CRC screening guidelines in our study, as has been demonstrated by others [8–10, 20]. Perhaps we did not find this to be a factor in our study because only a small percent (7.8%) of the participants had not completed a high school education.

Health care utilization, as assessed by whether or not a participant reported having had a check-up in the past two years, was also positively associated with being within CRC screening guidelines. This is an indication that seeking healthcare and the recency of a doctor’s visit simply provides patients with an opportunity to have a CRC screening discussion with their provider. In support of this hypothesis, frequency in visiting a healthcare provider has been related to several health promoting and preventive care behaviors, including cancer screening tests in prior studies [8–10, 20, 21]. In another Appalachian population, a positive dose-response relationship between co-morbid conditions and the odds of being screened for CRC was observed [28]. The study investigators suggested that the increased screening among individuals with a higher number of chronic health conditions was attributable to the necessity of their management, which required more frequent interactions with healthcare providers, and thereby increased opportunities for CRC screening discussions [28].

The importance of patient-provider communication, either in terms of asking a doctor to order a CRC screening test or being asked by a doctor to have a test, was again underscored in this study. A doctor's recommendation to get tested had the highest odds ratio (6.95) of any variable assessed. This is not surprising, as many studies have found that a doctor's recommendation is the main reason people make health promoting changes (*e.g.,* complete cancer screening tests) [45–48].

Lastly, social influence, in terms of being encouraged to get a CRC screening test by someone other than a physician, was also positively associated with being within guidelines. This positive effect of encouragement on health behaviors has been known for decades, especially among underserved populations. Intervention research has documented the success of lay health workers/advisors, "*promotoras*," and patient navigators who help guide patients through the CRC screening process, as well as provide encouragement for screening by providing patients with social and emotional support [49–57]; however, to date, limited data are available on the association between social influence and increases in CRC screening uptake, specifically in rural populations [57]. In their study [57], Moralez and colleagues showed that their *promotora* led educational intervention significantly increased knowledge and uptake of CRC screening tests in a sample of Hispanic, rural residents, likely due to the social support, comfort, and culturally appropriate knowledge provided by the promotoras.

The strengths of this study include the use of a population-based sample, with a fairly large number of residents from 12 Ohio Appalachian counties, thus allowing us to generalize our findings to a large geographic region. Several prior studies of CRC screening conducted among residents of Appalachia have been among smaller samples, usually from fewer counties [24, 29, 32, 58]. In addition, we used multiple imputation to minimize missing data, which allowed us to report on a fairly large sample. Our survey also collected information on factors related to social influence (*i.e.,* encouragement and discouragement for screening), which have not been widely examined in studies of rural residents.

This study also had several limitations. First, the response rate was 35%. This rate is not ideal, however, it is likely an indication of the downward trend in participation rates observed over the past several years for many national surveys that have used similar sampling techniques [59]. In addition, we did not have MRR on all participants, reducing our sample size. Since MRR data have been shown to be more accurate than self-report, especially for CRC screening [60], we chose to use this to measure screening behaviors, with imputation for missing data. Our recent findings support the use of MRR data, given the variable concordance observed between self-report and MRR data for utilization of CRC screening tests and that some participant characteristics are related to accurate self-reporting in this population [61].

In summary, a population-based cross-sectional survey among residents living in 12 Ohio Appalachian counties, aged 51–75 years found that half of respondents were not screened within recommended guidelines for CRC by medical record review. This finding helps to explain the higher CRC incidence and mortality rates in this region. Moreover, results point to four factors that can be used to increase CRC screening rates among residents of Appalachia – improving access to healthcare, increasing utilization of healthcare, improving physician-patient communication about CRC screening, and enhancing social influence on CRC screening. Researchers and health care providers can develop and implement strategies directed at these issues to improve CRC screening rates in this underserved region to ultimately reduce CRC disparities.

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Table 1

Characteristics associated with being within CRC screening guidelines by medical record review

	All participants (n=1085)	Complete cases (n=713)[a]		Imputation results (n=1085)	
Characteristic		**Not within guidelines (n=360) n (%)**	**Within guidelines (n=353) n (%)**	**OR (95% CI)[b]**	***P***
Age (years), mean±SD[c]	61.4±6.8	61.0±6.6	62.6±6.9	1.04 (1.02, 1.06)	0.0005
Gender					
Male	449 (41.4)	149 (41.4)	143 (40.5)	1.00 (referent)	
Female	636 (58.6)	211 (58.6)	210 (59.5)	1.05 (0.80, 1.37)	0.74
Race					
Non-white	35 (3.2)	8 (2.2)	9 (2.5)	1.00 (referent)	
White	1050 (96.8)	352 (97.8)	344 (97.5)	1.10 (0.45, 2.69)	0.84
Marital status					
Single/never married	47 (4.3)	15 (4.2)	11 (3.1)	1.00 (referent)	
Married/living as married	839 (77.3)	275 (76.4)	294 (83.3)	1.76 (0.87, 3.55)	0.12
Divorced/separated/widowed	199 (18.3)	70 (19.4)	48 (13.6)	1.16 (0.54, 2.49)	0.70
Educational attainment (years)					
<12	85 (7.8)	29 (8.1)	23 (6.5)	1.00 (referent)	
12	385 (35.5)	119 (33.1)	115 (32.6)	1.33 (0.76, 2.34)	0.32
>12	615 (56.7)	212 (58.9)	215 (60.9)	1.39 (0.81, 2.39)	0.23
Employment status					
Employed full- or part-time	485 (44.7)	162 (45.0)	139 (39.4)	1.00 (referent)	
Unemployed/disabled	182 (16.8)	68 (18.9)	47 (13.3)	0.78 (0.53, 1.16)	0.22
Retired/volunteer	418 (38.5)	130 (36.1)	167 (47.3)	1.44 (1.06, 1.96)	0.02
Household income[d]					
<$30,000	302 (33.3)	120 (37.6)	75 (24.5)	1.00 (referent)	
$30,000–$60,000	302 (33.3)	93 (29.2)	118 (38.6)	2.01 (1.41, 2.86)	0.0001
≥$60,000	303 (33.4)	106 (33.2)	113 (36.9)	1.72 (1.22, 2.45)	0.002
Health insurance status					
Uninsured	94 (8.7)	46 (12.8)	14 (4.0)	1.00 (referent)	
Public insurance only	142 (13.1)	50 (13.9)	35 (9.9)	2.16 (1.06, 4.40)	0.03

Characteristic	All participants (n=1085)	Complete cases (n=713)^a		Imputation results (n=1085)	
		Not within guidelines (n=360) n (%)	Within guidelines (n=353) n (%)	OR (95% CI)^b	***P***
Private insurance only	564 (52.0)	183 (50.8)	180 (51.0)	3.16 (1.74, 5.74)	0.0002
Public and private insurance	285 (26.3)	81 (22.5)	124 (35.1)	5.08 (2.71, 9.51)	<0.0001
Smoking status					
Never	585 (53.9)	192 (53.3)	191 (54.1)	1.00 (referent)	
Former	374 (34.5)	127 (35.3)	129 (36.5)	1.07 (0.80, 1.44)	0.63
Current	126 (11.6)	41 (11.4)	33 (9.3)	0.81 (0.52, 1.28)	0.37
Self-reported health status					
Poor/fair	160 (14.7)	63 (17.5)	45 (12.7)	1.00 (referent)	
Good/very good/excellent	925 (85.3)	297 (82.5)	308 (87.3)	1.27 (0.85, 1.89)	0.24
Medical condition(s) requiring regular medical visits					
No	348 (32.1)	109 (30.3)	97 (27.5)	1.00 (referent)	
Yes	737 (67.9)	251 (69.7)	256 (72.5)	1.30 (0.98, 1.75)	0.07
Have a regular primary care provider					
No	78 (7.2)	16 (4.4)	3 (0.8)	1.00 (referent)	
Yes	1007 (92.8)	344 (95.6)	350 (99.2)	10.26 (3.51, 29.92)	<0.0001
Check-up/physical in the past 2 years					
No	118 (10.9)	44 (12.2)	11 (3.1)	1.00 (referent)	
Yes	967 (89.1)	316 (87.8)	342 (96.9)	5.44 (2.87, 10.31)	<0.0001
High CRC risk perception					
No/don’t know	980 (90.3)	325 (90.3)	312 (88.4)	1.00 (referent)	
Yes	105 (9.7)	35 (9.7)	41 (11.6)	1.18 (0.76, 1.83)	0.47
Aware of CRC screening tests					
No/don’t know	145 (13.4)	38 (10.6)	37 (10.5)	1.00 (referent)	
Yes	940 (86.6)	322 (89.4)	316 (89.5)	1.35 (0.89, 2.06)	0.16
Aware CRC screening should begin at age 50					
No	491 (45.3)	163 (45.3)	158 (44.8)	1.00 (referent)	
Yes	594 (54.7)	197 (54.7)	195 (55.2)	1.04 (0.79, 1.37)	0.79
Ever asked by a doctor to have a CRC screening test					
No/don’t know	243 (22.4)	115 (31.9)	17 (4.8)	1.00 (referent)	

	All participants (n=1085)	Complete cases (n=713)[a]		Imputation results (n=1085)	
Characteristic		**Not within guidelines (n=360) n (%)**	**Within guidelines (n=353) n (%)**	**OR (95% CI)[b]**	***P***
Yes	842 (77.6)	245 (68.1)	336 (95.2)	9.09 (5.52, 14.97)	<0.0001
Ever asked a doctor to order a CRC screening test					
No/don't know	961 (88.6)	327 (90.8)	299 (84.7)	1.00 (referent)	
Yes	124 (11.4)	33 (9.2)	54 (15.3)	2.04 (1.34, 3.13)	0.001
Ever encouraged by anyone (other than a doctor) to have CRC screening					
No/don't know	497 (45.8)	187 (51.9)	114 (32.3)	1.00 (referent)	
Yes	588 (54.2)	173 (48.1)	239 (67.7)	2.38 (1.78, 3.18)	<0.0001
Ever discouraged by anyone (other than a doctor) from having CRC screening					
No/don't know	1044 (96.2)	347 (96.4)	342 (96.9)	1.00 (referent)	
Yes	41 (3.8)	13 (3.6)	11 (3.1)	1.05 (0.47, 2.35)	0.91

[a] Complete cases were participants who completed the baseline survey and had their medical record reviewed to confirm CRC screening status.

[b] Odd ratios were calculated for the total sample using 40 multiple imputed datasets.

[c] Participants' ages ranged from 51–75 years.

[d] Income was missing for 178 participants.

Table 2

Multivariable logistic regression model for being within CRC screening guidelines by medical record review, n=1085

Variable	**OR (95% CI)**	***P***
Age (years)	1.04 (1.01, 1.07)	0.005
Household income		
<$30,000	1.00 (referent)	
$30,000–$60,000	1.92 (1.29, 2.86)	0.001
≥$60,000	1.80 (1.19, 2.72)	0.006
Have a regular primary care provider		
No	1.00 (referent)	
Yes	4.22 (1.33, 13.39)	0.01
Check-up/physical in the past 2 years		
No	1.00 (referent)	
Yes	2.37 (1.12, 4.99)	0.02
Ever asked by doctor to have a CRC screening test		
No/don’t know	1.00 (referent)	
Yes	6.68 (3.87, 11.52)	<0.0001
Ever asked a doctor to order a CRC screening test		
No/don’t know	1.00 (referent)	
Yes	2.24 (1.36, 3.69)	0.002
Ever encouraged by anyone (other than a doctor) to have CRC screening		
No/don’t know	1.00 (referent)	
Yes	1.57 (1.11, 2.22)	0.01