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Relationship of colorectal cancer awareness and knowledge with colorectal cancer screening

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SUMMARY

Aim—The aim was to describe the association of awareness and knowledge with participation in colorectal cancer (CRC) screening.

Materials & methods—Telephone survey research was conducted with South Carolina (USA) residents aged 50–75 years using a 144-item instrument. Data were analyzed with SAS and Stata. Adjusted odds ratios are reported.

Results—Respondents ($n = 1302$) had heard of CRC screening (96%) and exhibited high levels of CRC awareness and knowledge; only 74% had ever been screened. Higher levels of knowledge were associated with a greater likelihood of having ever been screened (odds ratio: 1.05; 95% CI: 1.02–1.41; $p < 0.001$).

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Disclaimer

The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

Ethical conduct of research

The authors received verbal informed consent over the telephone from respondents for this study, per their research protocol (University of South Carolina IRB tracking #Pro00002697).

Financial & competing interests disclosure

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Conclusion—Results showed high levels of awareness and knowledge, but modest participation in CRC. Transforming awareness and knowledge into CRC screening participation should be a priority.

Colorectal cancer (CRC) is one of the most common, deadly and preventable types of cancer. CRC is the third most commonly diagnosed cancer and second-leading cause of cancer death in the USA [1]. Many incident cases of CRC can be prevented or have the disease downstaged through participation in recommended screening, especially colonoscopy [2–9]. CRC screening is vastly underutilized in comparison with other types of cancer screening [4]. Thus, higher rates of disease and death persist with significant disparities by racial and ethnic groups, particularly among African-Americans, and by geographic location (i.e., urban or rural designation), particularly among those living in rural-designated areas [1–4]. According to the 2008 National Health Interview Survey findings, only 52% of individuals aged 50–75 years were adherent to CRC screening recommendations [101]. The Healthy People 2020 goal is 70.5% adherence. For cervical cancer, the goal is 93% adherence with 84.5% of women (aged 21–65 years) adherent to cervical cancer screening recommendations according to the 2008 National Health Interview Survey. For breast cancer, the goal is 81.1% adherence with 73.7% of women (aged 50–74 years) adherent to breast cancer screening recommendations according to the 2008 National Health Interview Survey. Given that CRC is a deadly cancer for both men and women and CRC screening has been shown to reduce mortality, it is appropriate to explore efforts to increase participation in CRC screening.

South Carolina (USA) ranks in the highest quartile among states in overall healthcare quality, yet it ranks in the lowest quartile (i.e., biggest disparity) in income-related disparity in healthcare quality [10]. The South Carolina population represents an important, medically underserved population in which to examine participation in CRC screening, particularly among African-Americans and rural-dwelling residents.

Efforts to increase CRC screening are a priority area in cancer prevention and control. The US Department of Health and Human Services report, Health and Human Services Action Plan to Reduce Racial and Ethnic Health Disparities, identified the percentage of eligible adults who receive CRC screening (Measure 7) as a key measure to determine the success of efforts to address health disparities [11]. Preceding the Health and Human Services action report was the NIH Consensus and State-of-the-Science Statements: Enhancing Use and Quality of Colorectal Cancer Screening [12]. This report emphasized several strategies for increasing participation in CRC screening, including the use of all recommended methods for CRC screening (not only colonoscopy).

CRC screening guidelines from national organizations recommend screening for average-risk individuals beginning at age 50 years with an annual fecal occult blood test (FOBT), a flexible sigmoidoscopy or barium enema every 5 years, or a colonoscopy every 10 years [2,13]. The American College of Gastroenterology is the only national organization that recommends African-Americans to begin screening at the age of 45 years for average-risk adults due to the CRC disparities [14]. CRC screening guidelines differentiate tests that prevent disease (i.e., detect precancerous adenomatous polyps) and/or tests that detect

disease [13]. Variations in screening guidelines have resulted in the development of consensus statements to provide guidance to clinicians [15]. Furthermore, CRC screening guidelines depend on personal and family history thus increasing the complexity of the recommendations.

Rates of CRC screening are incrementally increasing in the USA, but noted disparities in participation among subgroups, such as rural individuals, racial and ethnic minorities (including African–Americans), those without health insurance, those with low income levels (<US \$35,000 per year) and those with less than a high school education persist [3,4,16–20]. African–Americans are less likely to participate in CRC screening (62.9%) compared with their European–American/white counterparts (66.2%). The reasons for disparities in cancer screening, and specifically CRC screening, are complex and not well understood. Socioeconomic status and access to healthcare continue to be major factors in determining participation in CRC screening among African–Americans [4,16,18,21–34]. Uninsured individuals continue to have the lowest levels of CRC screening, and African–Americans comprise a large proportion of the uninsured and underinsured in the USA [4,34–36]. Cost, physician recommendation and regular contact with the medical system are major factors in determining participation in CRC screening, and for which African–Americans face greater barriers in financial and geographic access to care [16,23,26–33,37–49]. Healthcare system barriers, such as lack of healthcare provider recommendation, inadequate referral systems for screening, emphasis on management of competing comorbid conditions and insurance coverage impede uptake of CRC screening, and the role of healthcare providers and administrators in recommending participation in screening among patients negatively impacts participation [50,51]. Lower rates of CRC screening participation among African–Americans have previously been shown to be correlated with marginal levels of CRC knowledge and fatalistic beliefs and attitudes about cancer screening [18,23,25,26,30,45,52–60]. CRC knowledge and participation in screening tend to be lower among individuals with lower levels of educational attainment and limited economic opportunity although the nature and influence of these contextual factors are not well studied or understood [4,18,23,26,30,51,59–61]. Understanding the relationship of awareness and knowledge with CRC screening is useful to develop appropriate interventions and increase participation in CRC screening.

The aim of this study was to describe the relationship of CRC awareness and knowledge with CRC screening participation among a population-based sample of screening-age men and women (aged 50–75 years) in South Carolina.

Materials & methods

A cross-sectional, population-based, random-digit dialed telephone survey of CRC screening-age men and women (aged 50–75 years) in South Carolina was conducted in 2009. The telephone survey was administered by a professional survey research firm. Randomly selected nonrestricted landline and cellular telephone numbers with South Carolina area codes (Survey Sampling, Inc.) were automatically dialed. Eligible respondents were male and female residents of South Carolina (i.e., lived in the state the majority of the time); aged 45–75 years (focus of this analysis on screening age only, i.e., 50–75 years); had

no hearing, speaking or cognitive difficulties to prevent completion of a telephone interview; and had the ability to hear, speak and respond in English. From May to August 2009, trained male and female interviewers administered a 144-item instrument using computer-assisted telephone interviewing. The 144-item instrument was designed to assess personal, social and behavioral correlates, including CRC awareness and knowledge, of participation in CRC screening. Extensive instrument development included a systematic literature review, external expert review and multiphase pretesting. Existing questionnaire items, previously used in cancer prevention and control research in South Carolina and nationwide, and newly identified items were included in the final instrument. The instrument used 'colon cancer' rather than 'colorectal cancer' due to literacy concerns identified during pretesting. The reading grade level of the instrument was 8.1. A 'plain language' definition of colon cancer was provided to all respondents, and 'plain language' definitions for other medical and technical terms (e.g., colonoscopy, polyp and Crohn's disease) used in the instrument were included for interviewers to reference to standardize information provided to respondents and to optimize comprehension among respondents. Eligibility was determined by a series of prescreening items before beginning the survey. When eligible respondents agreed to participate in the study, respondents were asked a series of questions to confirm their understanding of what was expected of them as a respondent and to confirm that they agreed to voluntarily participate. This verbal informed consent process with a standardized interviewer script is routinely used in telephone-based survey research and was approved by the University's Institutional Review Boards. At the end of the telephone survey, interviewers provided respondents with a toll-free number to access information on CRC and the contact information of the lead investigator (Heather M Brandt).

A total of 1532 respondents responded to the survey with 29 partial completions, which were excluded. The total sample was 1503. The average completion time was 28.5 min (range: 9–70 min). Defined as 'completed interviews + partially completed interviews + refusals + language barrier + ill or (senile + consistent answering machines + unable to complete during fielding period + never answered numbers)', the response rate was 36.6%. This rate is similar to the response rate for other telephone surveys with initial screening eligibility questions administered prior to enrollment [62]. A series of initial screening questions were used to assess age, South Carolina residence, gender, ethnicity and race. Once the desired proportions of respondents were enrolled, no more individuals who possessed this (these) characteristic(s) were enrolled. Because there was no information collected from nonresponders either initially or at follow-up, we could not assess whether there was a difference between responders and non-responders. As noted in the eligibility criteria, individuals meeting other eligibility requirements between the ages of 45 and 49 years were included in the sampling process to assess correlates of CRC screening prior to the recommended age of initiation of routine CRC screening. Only respondents of screening age (50–75 years) were included in the final sample (n = 1302) and analysis for this study. Sufficient statistical power was retained to assess the relationship of awareness and knowledge with screening. The survey research firm provided a technical report of data collection procedures, including response, completion, participation rates and information on US Census-weighted variables (i.e., age and race). Lastly, the survey research firm provided an error-free data file in SAS format.

Measures

The main dependent variable was self-reported participation in CRC screening, specifically undergoing screening by FOBT, flexible sigmoidoscopy and/or colonoscopy. Two dependent variables were created. If respondents indicated participation in one CRC screening test, the respondent was considered 'ever been screened'. Adherence to CRC screening was calculated using current age, age at first CRC screening test and lifetime number of tests. Adherence status was based on the type of CRC screening test.

The main independent variables were awareness and knowledge of CRC. Four awareness items and 14 knowledge items were analyzed by item and by creating a composite index score. Awareness was assessed by the following questions: "Have you ever heard of colon cancer?", "Have you ever heard of colon cancer screening?", "Can you name any of the screening tests for colon cancer?" and "Which colon cancer screening tests can you name?" Responses were "Yes," "No" and "Don't know." Knowledge was assessed by items such as, "Colon cancer usually develops over a period of several years", "Generally, colon cancer screening should start at age 50", "Colon cancer starts as a polyp, which is a small growth found in the colon", and "People eating a low fat and high fiber diet seem to have a lower risk of colon cancer." Responses were "True," "False" and "Don't know."

Analysis

Data were analyzed using SAS and Stata. Descriptive statistics summarized descriptive information about respondents and responses to awareness, knowledge and CRC screening items. Bivariate associations were examined prior to using logistic, ordered logistic and linear regression to assess the relationship of awareness and knowledge with covariates and CRC screening participation. Analyses were adjusted using sampling weights so results reflect population characteristics of the state of South Carolina; sampling weights were not adjusted for nonresponse because no information was collected about nonresponders. Odds ratios were adjusted (aOR) for race, gender, age, whether the subject has graduated from high school, whether income is over \$75,000 per year, marital status, whether insured and whether from an urban setting. Statistical tests were considered significant at $p = 0.05$. Confidence intervals (95%) were calculated. An awareness score (range: 0–4) was created by assigning +1 to each of three awareness items if the respondent answered "Yes." One additional point was awarded if the respondent could name a screening test. A knowledge score (range: 0–14) was created by assigning +1 for every item answered correctly. "Don't know" responses were considered to be incorrect for the knowledge score.

The knowledge and awareness scores were analyzed using ordered logistic and linear regression models with no difference in inference. Inference outside of the range of covariates could imply scores outside of the possible range, but since all covariates are discrete this is not an issue and inference is in terms of means for covariate patterns. While there was some evidence of heteroskedasticity, there was no evidence of collinearity (all variance inflation factors were less than 1.5), no evidence of missing covariates and no evidence that the identity link was inappropriate. The knowledge scores are skewed overall, but not for the individual covariate patterns. Thus, the data satisfied the assumptions for interpretation in a linear regression setting.

Results

Respondents (n = 1302) were mostly female (63%), European–American (77%), had at least some college education (59%), were married or lived with a partner (62%) and had some type of health insurance (81%). The mean age of respondents was 60.3 (standard deviation [SD]: 8.6; range: 50–75) years. For selected descriptive characteristics of respondents, the 2000 US Census estimates for the South Carolina population (2008 updated at time of study) are provided to show comparison between the respondents and the population base. It is important to note that race and ethnicity were asked separately, and the low proportion of Hispanic or Latino/a respondents did not allow for further subgroup analysis by ethnicity. Descriptive characteristics of respondents are shown in Table 1.

Bivariate comparisons between descriptive characteristics shown in Table 1 by main outcome variables are provided in Table 2. For ‘ever been screened’, age, relationship status and insurance status were significant. For ‘adherence to any screening method’, race, age, whether the subject has graduated from high school, whether income is greater than \$75,000 per year, marital status and whether the subject has insurance were significantly associated. For the knowledge score, gender, race, education, income, insurance status, and urban or rural designation were significant.

Awareness items are shown in Table 3. The majority of respondents had heard of CRC (91%). Of those who had heard of colon cancer, the majority had heard of CRC screening (96%). More than half of the respondents (62%) said they could name a CRC screening test. The most common CRC screening test named was the colonoscopy (90%), followed by FOBT (20%) and flexible sigmoidoscopy (14%). The mean awareness score was 3.0 (SD: ± 1.4) with the majority of respondents having an awareness score of 3.0 (62%).

Knowledge items are shown in Table 4. The three knowledge items with the highest percentage of correct responses were: “Colon cancer starts as a polyp, which is a small growth found in the colon” (~100% answered “True”), “A colonoscopy is the most accurate test to check for polyps in the colon and rectum” (99% answered “True”), and “People who have a family history of colon cancer tend to have a lower risk of colon cancer (94% answered “False”). The item with the lowest percentage of correct answers was: “Colon cancer is most often caused by a person’s behavior or lifestyle” (30% answered “True”). Two items had “Don’t know” responses >25%: “African–Americans should start screening at age 45” (27% answered “Don’t know”) and “People with high alcohol consumption seem to have a lower risk of colon cancer” (27% answered “Don’t know”). The mean knowledge score was 9.6 (SD: ± 3.8) with 46% of respondents correctly answering between eight and 11 items. CRC screening participation is shown in Table 5. Seventy four percent of respondents who had had any of the three CRC screening tests were included in this analysis. The most common screening test was colonoscopy (70%) followed by FOBT (35%) and flexible sigmoidoscopy (31%).

Logistic regression of CRC screening tests by awareness score and knowledge score is shown in Table 6. A one-unit increase in awareness score significantly increased the odds of respondents being more likely to have had any screening test (aOR: 1.43; 95% CI: 1.30–

1.59; $p < 0.001$), colonoscopy (aOR: 1.43; 95% CI: 1.29–1.57; $p < 0.001$), flexible sigmoidoscopy (aOR: 1.27; 95% CI: 1.13–1.41; $p < 0.001$), or FOBT (aOR: 1.13; 95% CI: 1.02–1.25; $p = 0.016$). A one-unit increase in knowledge score significantly increased the odds of respondents being more likely to have had any screening test (aOR: 1.06; 95% CI: 1.02–1.09; $p = 0.004$), FOBT (aOR: 1.04; 95% CI: 1.00–1.07; $p = 0.043$), or colonoscopy (aOR: 1.05; 95% CI: 1.02–1.10; $p = 0.003$). A one-unit increase in knowledge score increased the odds of respondents being more likely to have had a flexible sigmoidoscopy (aOR: 1.04; 95% CI: 1.00–1.07; $p = 0.054$) although these results were not significant. In all of these results relating one-unit increases in knowledge scores to the likelihood of various outcomes, a one-unit increase reflects one additional correct answer. An aOR of 1.06 for any screening method relative to knowledge indicates that, on average, persons who correctly answer one additional question have 1.06-times the odds of getting screened for CRC. Furthermore, these effects are multiplicative. On average, persons who answer four more questions correctly have $1.06^4 = 1.26$ times the odds of getting screened. Thus, although statistical significance is presented for the average difference (in terms of aOR) for a one-unit increase, a novel intervention may target a practical difference reflecting an increase of several correct questions on average.

Logistic regression of having any CRC screening test and colonoscopy was compared by awareness score and knowledge score (Table 7). Respondents who had heard of a colonoscopy had greater odds of having had any CRC screening test (aOR: 1.71; 95% CI: 1.06–2.76; $p = 0.028$) and of having had a colonoscopy (aOR: 1.59; 95% CI: 1.03–2.45; $p = 0.34$). Respondents who could name at least one CRC screening test had greater odds of having had any CRC screening test (aOR: 3.74; 95% CI: 2.76–5.08; $p < 0.001$) and of having had a colonoscopy (aOR: 3.69; 95% CI: 2.83–4.82; $p < 0.001$). A one-unit increase in awareness score was significantly associated with increased odds of having any CRC screening test (aOR: 1.44; 95% CI: 1.30–1.59; $p < 0.001$) and of having had a colonoscopy (aOR: 1.43; 95% CI: 1.29–1.57; $p = 0.002$). A one-unit increase in knowledge score was significantly associated with increased odds of having any CRC screening test (aOR: 1.05; 95% CI: 1.02–1.10; $p = 0.004$) and of having had a colonoscopy (aOR: 1.05; 95% CI: 1.02–1.09; $p = 0.003$).

Table 8 shows logistic, ordered logistic and linear regression (as noted) results of the awareness score, knowledge score and CRC screening tests (any of the three CRC screening tests, FOBT, flexible sigmoidoscopy and colonoscopy) by gender, race, urban or rural designation, age, education, income, relationship status and insurance status. A number of statistically significant observations were identified. Significant differences in knowledge scores were observed between African–American and European–American respondents (lower knowledge among African–American respondents) and by level of education (lower knowledge among those who had not graduated from high school). Awareness scores were significantly lower among males, African–Americans and those who had not graduated from high school. African–American respondents were significantly more likely than European–American respondents to have had a FOBT. Flexible sigmoidoscopy was more common among older respondents and those who did not have insurance. Colonoscopy was significantly less likely among males, African–Americans, respondents living in rural-

designated areas, those with younger age, those who had not graduated from high school and those without insurance.

Discussion

This study was the largest cross-sectional study of CRC screening among screening-age adults in South Carolina to date and provides information that may also be useful to other states in southeastern USA where CRC screening participation is lower than ideal and confounded by social determinants indicative of disparities in CRC disease outcomes. The final sample for this study had a higher proportion of females, was older, had higher levels of education and was more likely to be married compared with the population characteristics of the state of South Carolina. This is somewhat expected given the limited age range of eligible respondents (i.e., 50–75 years) and based on previous telephone survey research [62,63]. Sampling weights were used to increase the representativeness of the study sample to the state to increase the validity of findings.

CRC screening participation among respondents was higher than recently reported rates for South Carolina. In this study, 74% of respondents reported ever being screened for CRC with the majority (70%) indicating colonoscopy. Recent data show 66% of South Carolinians have had an FOBT in the past year and/or lower endoscopy in the past 10 years [4]. We defined adherence using guidelines for number of screening examinations over time for each screening test and constructed an indicator variable for each screening test and for having adhered to any of the screening guidelines. It is also recognized that ‘ever having been screened’ rates are likely to be higher than those for adherence to recommended screening guidelines. Given the noted benefits of CRC screening tests that detect precancerous polyps and can prevent incident cases, there is concern about the mode of testing by race in this study. African–American respondents were more likely to have had a FOBT and less likely to have had a colonoscopy compared with European–American respondents. Data not shown indicate that African–American respondents were more likely to report physician recommendation for FOBT compared with colonoscopy, and this could be an important system-level factor deserving of further study and intervention [64]. Differences by urban or rural designation were most notable in subjects ‘ever having had a colonoscopy’ with urban respondents being more likely than rural respondents. African–Americans and rural residents stand to benefit greatly from increased access to colonoscopy and the ability to prevent incident cases of CRC, yet our study shows lower participation and great opportunity for further examination of facilitators and barriers to increase participation in colonoscopy, in particular.

Awareness scores and knowledge scores indicated high levels of CRC awareness and knowledge among respondents. Awareness and knowledge were positively linked to increased likelihood of ever being screened for CRC and adherence to CRC screening recommendations for the full sample. This is consistent with previously reported findings showing a positive correlation between awareness and knowledge and participation in CRC screening, including differences in CRC screening participation by race [18,25,26,30,47,54–56,58–60,65]. Differences by race were observed in this study when comparing African–American and European–American respondents. African–American respondents had lower

levels of CRC awareness and knowledge compared with European–American respondents. Approaches to increase participation in CRC screening among groups experiencing persistently higher rates of CRC incidence and mortality in light of overall declines in CRC incidence and mortality are urgently needed so that everyone benefits. The differences in awareness and knowledge between African–American respondents and European–American respondents may point to the need for culturally appropriate and culturally targeted interventions to increase participation in CRC screening.

CRC screening recommendations vary by organization, which could contribute to confusion on behalf of consumers. Because CRC screening guidelines have increased in complexity, it is unknown whether guidelines are fully understood by those in the recommended age range for screening. The American College of Gastroenterology recommends starting screening at 45 years of age for African–Americans and 50 years of age for the rest of the general populations. Other organizations recommend screening starting at 50 years of age for all average-risk individuals. Overall, all organizations recommend having a colonoscopy every 10 years, a flexible sigmoidoscopy (concurrently with an FOBT or alone) every 5 years or an FOBT annually. This warrants monitoring and additional study.

Culturally targeted interventions to increase participation in CRC screening have been successful previously and are recommended [12,51,53,61,66–73]. The Community Guide includes recommendations for client-oriented and provider-oriented strategies inclusive of efforts to address awareness and knowledge in addition to increasing actions, in this case CRC screening, that are appropriate for cultural targeting [74]. Specifically for increasing CRC screening, recommended client-oriented strategies for which sufficient evidence exists to support intervention include client reminders (e.g., follow-up telephone or mailed print reminders about screening), small media (e.g., printed brochures), one-on-one education (e.g., conversations between a healthcare provider, health educator or lay health advisor and an individual due for screening), and reducing structural barriers (e.g., reducing time/distance to a facility for screening, modifying hours of service and simplifying administrative procedures) [74]. Recommendations for provider-oriented strategies include provider assessment and feedback (e.g., provide information on quality of screening services provided and proportion of eligible patients receiving recommended screenings as appropriate) and provider reminder and recall systems (e.g., cues to alert providers that a patient is due for screening) [74]. Each of the recommended strategies includes awareness and educational components addressing knowledge and subsequent action that could positively contribute to increased participation in CRC screening.

While not a main focus of the study, it is important to note the role of access to care in adherence to CRC screening recommendations. In this study, insurance status was significantly associated with having had any CRC screening test, flexible sigmoidoscopy and colonoscopy, which shows a strong correlation between having insurance coverage and being screened. This is expected given the high proportion of respondents with insurance coverage, mostly Medicare due to the older age of the sample. Access to care is a multidimensional concept that extends beyond merely having a physical place to be screened. Access to care encompasses affordability, availability, accessibility, accommodation and acceptability [48,49]. The Patient Protection and Affordable Care Act

will address financial access (i.e., affordability) for preventive services, such as CRC screening, and may address other dimensions of access to care. However, it seems clear that additional efforts will be needed most likely to examine and intervene appropriately to ensure availability, accessibility, accommodation and acceptability in order to address shortcomings in CRC screening. Awareness and knowledge play a role in facilitating access to care, and such efforts to make connections to CRC screening are an equally important part of future intervention efforts to increase participation in CRC screening.

Limitations

The cross-sectional design of the study allowed for a snapshot of relationships between awareness and knowledge and participation in CRC screening. As a result, it was impossible to determine the direction of influence in our analyses as would be possible in a prospective study design. While the population-based approach to sampling and large sample size were strengths of this study, sampling weights were used to adjust for demographic characteristics of the study sample that were slightly different from South Carolina as a whole. The survey was long (144 items) and on average required just under 30 min to complete (28.5 min). This may have affected the response rate. In addition, using a targeted sampling approach may have also impacted the response rate. The response rate was 36.6%, which is similar to other computer-assisted telephone interviewing response rates from household phones [62]. Unfortunately, there is no way to determine if there was a difference between responders and nonresponders due to the sampling procedures for a narrow sample population. For example, once the desired proportion of European-Americans was reached, no more individuals identifying as European-American were included. It is also important to note that telephone survey methodology has inherent limitations, but methods were employed to maximize participation [62,63]. The survey research firm utilized the Behavioral Risk Factor Surveillance Survey (CDC) methodology for random-digit dial surveys to contact potential respondents on all days of the week during a wide range of calling hours [75]. Additional challenges that may have affected the response rate were answering machines and caller identification, which can reduce the response rate [62,63]. Self-reported participation in CRC screening may be considered a limitation, but self-reported participation in cancer screening has shown 'dependable agreement' with provider report, medical records review and health insurance claims data [76–79].

Conclusion & future perspective

Based on our results, levels of CRC awareness and knowledge among our South Carolina respondents were relatively high, yet participation in CRC screening was not commensurate. Disparities by race, gender, urban or rural designation, educational level and age in awareness, knowledge and/or participation in CRC screening existed and confirmed previous reports. It is also reasonable to assume that dimensions of access to care are important factors when examining participation in CRC screening [48,49]. While awareness and knowledge of CRC screening may be critical pre cursors and components of undergoing screening, awareness and knowledge alone may be insufficient for increasing overall participation in CRC screening, especially for African-Americans and rural populations, to the levels of participation in screening for other types of cancer. Approaches to addressing

attitudinal and system-level barriers that impact the application of high levels of CRC awareness and knowledge to CRC screening are needed. Our findings support recommendations for targeting interventions to the characteristics and preferences of a target population to increase participation in CRC screening. Additional research is needed to further examine the relationship between awareness and knowledge and timeliness and adherence to CRC screening intervals.

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Summary points

- Despite the ability to prevent the development of colorectal cancer (CRC) and downstage disease, the participation in CRC screening lags behind screening for other types of cancer.
- CRC awareness and knowledge have been shown to be positively associated with participation in screening, and there has been significant focus on addressing awareness and knowledge in CRC intervention research.
- In our study, CRC awareness and knowledge levels were high overall, yet participation in CRC screening was modest.
- Awareness and knowledge levels and CRC screening participation were lower in African–American respondents compared with white respondents. Culturally appropriate and culturally targeted efforts to increase awareness and knowledge, while facilitating participation in CRC screening, may be productive.
- Awareness levels and participation in colonoscopy were lower in rural-dwelling respondents compared with urban respondents, which may reflect access to CRC screening issues among rural-dwelling respondents.
- Future interventions should focus on transforming CRC awareness and knowledge into CRC screening through recommended strategies, such as client- and provider-oriented intervention strategies recommended in The Community Guide, and strategies documented in recent reviews of successful cancer screening interventions by addressing attitudinal and system-level factors.

Table 1

Descriptive characteristics of respondents (n = 1302).

Characteristic	f	%	South Carolina (USA) population, 2000 (2008 updated as available) [†] (%)
Gender			
Male	483	37	49
Female	819	63	51
Ethnicity: Hispanic or Latino/a (Yes)	22	2	3
Race			
African–American/black	275	21	29
European–American/white	1003	77	69
Other	24	2	2
Age (mean = 60, SD = 8.6; years)			
50–54	250	19	19 (45–59)
55–59	242	19	–
60–64	267	21	11 (60–74)
65–75	543	41	–
Education			
Less than high school diploma	177	14	24
High school diploma or GED	360	28	30
Some college	283	22	19
College degree	471	36	20
Unknown	11	<1	–
Income			
Less than US\$25,000	322	25	25
US\$25,000–49,999	307	24	32
US\$50,000–74,999	192	15	22
More than US\$75,000	260	20	21
Unknown	221	17	–
Relationship status			
Single	92	7	26
Partner/married	792	61	54
Separated/divorced/widowed	408	31	20
Unknown	10	<1	–
Insurance status and type			
Insured	1194	92	81
Uninsured	108	8	19
Geographic location			
Urban	849	65	60
Rural	453	35	40

[†]US Census data available at the time of survey administration (2009) provided for comparison.

f: Frequency; GED: General educational development; SD: Standard deviation.

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Table 2

Bivariate comparisons between descriptive characteristics and outcome variables (p-values).

Descriptive characteristic	Outcome variables		
	Ever been screened	Adherent to screening	Knowledge score
Gender	0.305	0.190	0.001 *
Race	0.155	0.005 *	<0.001 *
Age	<0.001 *	<0.001 *	0.145
Education	0.416	0.025 *	<0.001 *
Income	0.180	<0.001 *	<0.001 *
Relationship status	0.011 *	0.003 *	0.264
Insurance status	<0.001 *	<0.001 *	0.002 *
Geographic location	0.222	0.164	0.005 *

* Statistically significant at p = 0.05.

Table 3

Awareness of colorectal cancer and colorectal cancer screening.

Awareness item	Yes	%
Have you ever heard of colon cancer, sometimes called colorectal cancer?	1185	91
Have you ever heard of colorectal cancer screening? [†]	1139	96
Can you name any of the tests for colon cancer? [‡]	811	62
Which colon cancer screening test can you name?[§]	Named the test option	
Colonoscopy	732	90
Fecal occult blood test	162	20
Flexible sigmoidoscopy	113	14
Some other test(s) not named above, e.g., barium enema and virtual colonoscopy	111	13
Awareness score (0–4)	f	%
0	117	9
1	46	4
2	328	25
3	811	62
4	763	59
Awareness score: mean = 3.0 (SD ± 1.4)		

Frequencies and percentages are from tabulations using survey weights to ensure generalizability to the South Carolina (USA) population.

[†] Question was only asked to those who answered “Yes” to ever heard of colon cancer; excluded five “Don’t know” responses (n = 1185).

[‡] Question was only asked to those who answered “Yes” to ever heard of colon cancer and answered “Yes” to ever heard of colon cancer screening; excluded 25 “Don’t know” responses (n = 1139).

[§] Question was answered only by those who said “Yes” to can you name any of the screening tests and preceding two items (n = 811).

f: Frequency; SD: Standard deviation.

Table 4

Knowledge of colorectal cancer and colorectal cancer screening.

Knowledge item	Total f (%)		
	True	False	Don't know
People with colon cancer have symptoms before being diagnosed	232 (18)	868 (67)	202 (16)
Colon cancer usually develops over a period of several years	839 (64)	187 (14)	276 (21)
There are ways to stop the development of colon cancer	931 (72)	115 (9)	256 (20)
Colon cancer is most often caused by a person's behavior or lifestyle	314 (24)	743 (57)	245 (19)
Generally, colon cancer screening should start at age 50	869 (67)	270 (21)	163 (13)
African-Americans should start screening at age 45 [†]	704 (54)	130 (8)	495 (38)
Colon cancer starts as a polyp, which is a small growth found in the colon	1152 (88)	6 (<1)	144 (11)
A colonoscopy is the most accurate test to check for polyps in the colon and rectum	1122 (86)	15 (1)	165 (13)
People eating a low-fat and high-fiber diet seem to have a lower risk of colon cancer	986 (76)	84 (6)	232 (18)
People with high alcohol consumption seem to have a lower risk of colon cancer	70 (5)	758 (558)	474 (36)
People who do not exercise seem to have a lower risk of colon cancer	130 (10)	884 (68)	288 (22)
People who have high levels of stress tend to have a lower risk of colon cancer	81 (6)	944 (73)	277 (21)
People who are overweight tend to have a lower risk of colon cancer	68 (5)	997 (77)	237 (18)
People who have a family history of colon cancer tend to have a lower risk of colon cancer	67 (5)	1072 (82)	163 (13)
Knowledge score (0–14) [†]	f	%	
0–3	137	11	
4–7	106	8	
8–11	597	46	
12–14	462	35	
Knowledge score: mean = 9.6 (SD ± 3.8)			

Frequencies and percentages are from tabulations using survey weights to ensure generalizability to the South Carolina (USA) population.

[†]“Don't know” responses were considered incorrect when calculating the knowledge score.

f: Frequency; SD: Standard deviation.

Table 5

Colorectal cancer screening history (n = 1302).

CRC screening test	Total f (%)					
	Physician recommended		Ever had test		Abnormal test	
	f	%	f	%	f	%
Any screening test	1137	87	1114	74	328	25
FOBT	721	55	451	35	89	7
Flexible sigmoidoscopy	428	33	403	31	49	4
Colonoscopy	989	76	905	70	248	27

Frequencies and percentages are from tabulations using survey weights to ensure generalizability to the South Carolina (USA) population.

CRC: Colorectal cancer; f: Frequency; FOBT: Fecal occult blood test.

Table 6

Logistic regression of colorectal cancer screening test by awareness and knowledge scores.

CRC screening test	Awareness score		Knowledge score	
	aOR (95% CI)	p-value	aOR (95% CI)	p-value
Any screening test	1.43 (1.30–1.59)	<0.001*	1.06 (1.02–1.09)	0.004*
FOBT	1.13 (1.02–1.25)	0.016*	1.04 (1.00–1.07)	0.043*
Flexible sigmoidoscopy	1.27 (1.13–1.41)	<0.001*	1.04 (1.00–1.07)	0.054
Colonoscopy	1.43 (1.29–1.57)	<0.001*	1.05 (1.02–1.10)	0.003*

Odds ratios were adjusted for race, gender, age, whether the subject has graduated from high school, whether income is over US\$75,000 per year, marital status, insurance status and whether from an urban setting. Model results used survey weights to ensure generalizability to the South Carolina (USA) population.

* Statistically significant at p = 0.05.

aOR: Adjusted odds ratio; CRC: Colorectal cancer; FOBT: Fecal occult blood test.

Table 7

Logistic regression of having any colorectal cancer screening test and colonoscopy by awareness and knowledge.

	<u>More likely to have had any CRC screening test</u>		<u>More likely to have had a colonoscopy</u>	
	aOR (95% CI)	p-value	aOR (95% CI)	p-value
Ever heard of colonoscopy	1.71 (1.06–2.76)	0.028*	1.59 (1.03–2.45)	0.034*
Named at least one CRC screening test	3.74 (2.76–5.08)	<0.001*	3.69 (2.83–4.82)	<0.001*
One unit increase in awareness score	1.44 (1.30–1.59)	<0.001*	1.43 (1.29–1.57)	0.002*
One unit increase in knowledge score	1.05 (1.02–1.10)	0.004*	1.05 (1.02–1.09)	0.003*

* Statistically significant at $p = 0.05$.

Odds ratios were adjusted for race, gender, age, whether the subject has graduated from high school, whether income is over US\$75,000 per year, marital status, insurance status and whether from an urban setting. Model results used survey weights to ensure generalizability to the South Carolina (USA) population.

aOR: Adjusted odds ratio; CRC: Colorectal cancer.

Table 8
Awareness, knowledge and colorectal cancer screening test by gender, race and urban or rural designation.

	Knowledge score β -Coef (95% CI); p-value	Awareness score aOR (95% CI); p-value	Any screening test aOR (95% CI); p-value	FOBT aOR (95% CI); p-value	Flexible sigmoidoscopy aOR (95% CI); p-value	Colonoscopy aOR (95% CI); p-value
Male	-0.42 (-0.87-0.04) 0.073	0.20 (0.31-0.9) 0.001*	0.86 (0.64-1.17) 0.346	0.96 (0.74-1.24) 0.757	1.11 (0.85-1.44) 0.434	0.73 (0.55-0.95) 0.021*
African-American vs European-American/white	-1.62 (-2.25 to -1.00) <0.001*	0.45 (-0.60-0.30) <0.001*	0.90 (0.62-1.30) 0.567	1.76 (1.29-2.39) <0.001*	1.24 (0.88-1.73) 0.215	0.71 (0.52-0.98) 0.037*
Urban	-0.02 (-0.47-0.43) 0.945	-0.60 (-0.16-0.05) 0.310	1.23 (0.90-1.69) 0.199	0.83 (0.64-1.08) 0.172	0.94 (0.71-1.24) 0.680	1.33 (1.02-1.76) 0.017*
Age	-0.36 (-0.83-0.11) 0.137	-0.04 (-0.16-0.07) 0.443	1.94 (1.41-2.68) <0.001*	1.18 (0.91-1.52) 0.205	1.82 (1.40-2.37) <0.001*	1.67 (1.27-2.19) <0.001*
Education	1.67 (1.12-2.20) <0.001*	0.44 (0.31-0.57) <0.001*	1.27 (0.91-1.75) 0.147	1.21 (0.93-1.59) 0.162	1.25 (0.94-1.67) 0.120	1.44 (1.08-1.91) 0.012*
Income	0.51 (-0.06-1.09) 0.082	0.09 (-0.51-0.23) 0.213	1.12 (0.72-1.72) 0.621	1.28 (0.91-1.80) 0.155	1.31 (0.93-1.84) 0.121	0.91 (0.63-1.33) 0.636
Relationship status	0.06 (-0.42-0.53) 0.818	-0.02 (-0.13-0.10) 0.775	0.93 (0.67-1.29) 0.681	0.97 (0.74-1.26) 0.797	1.16 (0.89-1.53) 0.274	1.11 (0.84-1.48) 0.488
Insurance status	-0.21 (-1.00-0.58) 0.606	0.05 (-0.14-0.23) 0.606	2.63 (1.67-4.17) <0.001*	1.41 (0.87-2.30) 0.158	2.27 (1.27-4.05) 0.006*	2.84 (1.81-4.48) <0.001*

Model results used survey weights to ensure generalizability to the South Carolina (USA) population.

Linear regression coefficients are listed for the knowledge score model. aORs (race, gender, age, whether graduated from high school, whether income is over US\$75,000 per year, marital status, insurance status and whether from an urban setting) are reported for models of awareness score and colorectal cancer screening tests. Ordered logistic regression was used for awareness score models. Logistic regression was used for models of colorectal cancer screening tests.

* Statistically significant at $p < 0.05$.

aOR: Adjusted odds ratio; Coef: Coefficient; FOBT: Fecal occult blood test.