RESEARCH ARTICLE

Colorectal Cancer

Examining connections between screening for breast, cervical and prostate cancer and colorectal cancer screening

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Practice points

- Participation in colorectal cancer (CRC) screening lags behind screenings for other types of cancer (e.g., breast, cervical and prostate). Increasing participation in CRC screening is important to prevention and control of CRC, as CRC screening can be a form of primary cancer prevention.
- CRC screening rates among African–Americans are typically lower than European–Americans. This disparity in screening is reflected in higher CRC incidence and mortality.
- In our study, among European–American women, participation in breast and cervical cancer screenings was associated with participation in any type of CRC screening and specifically colonoscopy. These results were not consistent among African–American women.
- Among all men, prostate-specific antigen tests and digital rectal examinations were associated with increased participation in colonoscopy.
- Breast, cervical or prostate cancer screening tests can serve as 'teachable moments' to promote CRC screening in hopes of increasing participation.
- Targeting these teachable moments using culturally appropriate strategies may help to overcome CRC-related barriers, such as fatalistic views or lack of knowledge and awareness, among minority populations.
- 'One-stop-shopping' protocols for cancer screening may also help to increase participation in CRC screening.

SUMMARY **Aim:** To compare participation in breast, cervical and prostate cancer screening with colorectal cancer (CRC) screening. **Materials & methods:** This random digit-dialed survey includes participants (aged 50–75 years) from South Carolina (USA). Past participation information in fecal occult blood test, flexible sigmoidoscopy, colonoscopy, mammography, clinical breast examination, Pap test, prostate-specific antigen and digital rectal examination was obtained.Adjusted odds ratios are reported. **Results:** Among European–American women, any cervical or breast cancer screening was associated with adherence to any

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CRC screening. Among African–American women, mammography was associated with adherence to any CRC screening. Digital rectal examination and prostate-specific antigen tests were associated with adherence to any CRC screening test among all men. **Conclusion:** Future research should explore approaches inclusive of cancer screening recommendations for multiple cancer types for reduction of cancer screening disparities.

KEYWORDS
- breast cancer screening
- cervical cancer screening
- colorectal cancer screening
- health disparities
- prostate cancer screening

Colorectal cancer (CRC) is one of the most common and deadly types of cancer in the USA. CRC is the third most commonly diagnosed cancer among men and women [1]. Detection and removal of adenomatous polyps through colonoscopies can aid in early detection and primary prevention of CRC and greatly reduce mortality [2,3]. The US Preventive Services Task Force recommends men and women aged 50 years and older to participate in CRC screening by having an annual fecal occult blood test (FOBT); a flexible sigmoidoscopy, double-contrast barium enema or computed tomography colonography every 5 years; or a colonoscopy every 10 years [3]. The Healthy People 2020 goal for CRC screening adherence is 70.5% [4]. However, the estimated percentage of individuals adhering to CRC screening ranges from 47 to 66% depending on the data source, sex, race and ethnicity [5–10]. CRC screening is underutilized compared with screening for other types of cancer. For example, participation and adherence for cervical or breast cancer screening among women is reported as high as 80% [7,9,11].

Racial disparities among many types of cancer and cancer screening, including CRC, have been observed and are likely a product of multiple, intersecting and complex causes [12]. Even after adjustment for sex, income, age and access to healthcare, which are factors that are typically associated with CRC screening among the general US population [13], African–Americans (AAs) still suffer disproportionately from lower rates of CRC screening [14]. Hébert *et al.*, found a CRC mortality-to-incidence ratio, an indicator of survival that incorporates both incidence and mortality, among AAs of 0.418 (95% CI: 0.390–0.447), whereas the mortality-to-incidence ratio was only 0.344 (95% CI: 0.330–0.360) among European–Americans (EAs); this difference was statistically significant [15]. Although rates of CRC screening are increasing in the USA, one possible explanation for the racial differences in CRC incidence and mortality are racial disparities in CRC screening [4]. Studies, including those from the Behavioral Risk Factor Surveillance System (BRFSS), indicate increased prevalence or odds of CRC screening among EAs compared with AAs [4,6,7,16–17]. Additional examination of differences in screening for multiple types of cancer is warranted to elucidate strategies for intervention to increase participation among AAs or other racial and ethnic groups.

Basic demographic and socioeconomic factors, in addition to race, may not fully explain the difference in CRC screening between AAs and EAs [18]. Other factors, such as health insurance, medical care costs, physician recommendation and regular contact with a medical system, are major factors that influence CRC screening participation, and for which AAs face greater financial or geographic barriers [4,8,19–26]. In addition, screening for breast, cervical or prostate cancer has been shown to be associated with CRC screening among several different populations (e.g., EA, AA, Hispanic, male or female populations) [5,7,16–18,27–33]. However, not every study has found significant associations between CRC screening and other cancer screenings [18]. Carlos and colleagues suggest that using the setting of screening for one type of cancer can encourage and increase adherence for screening of another cancer type [34].

Of the studies that examined the relationship between breast, cervical, prostate and CRC screening, none have examined both men and women and EAs and AAs, as well as utilized the number of cancer screening tests assessed (i.e., mammography, clinical breast examination, Pap test, prostate-specific antigen (PSA) test, digital rectal examination [DRE], colonoscopy, flexible sigmoidoscopy and FOBT) within the same population. The purpose of this study was to examine participation in breast, cervical or prostate cancer screening in comparison to participation in CRC screening, and to see if this comparison differed by race. We hypothesized that the odds of participation in mammography, clinical breast examinations or Pap tests among women, or PSA or DRE tests among men would be greater among those adhering to CRC screening recommendations compared with those who do not adhere to CRC screening.

Materials & methods

• Study population

A random-digit dialed telephone survey was conducted among men and women of CRC screening age (50–75 years) in South Carolina (SC; USA) from May to August of 2009. This cross-sectional, population-based telephone survey utilized automatically dialed landline and cellular telephone numbers with SC area codes provided by Survey Sampling Incorporated [4]. Surveys were administered by trained male and female interviewers through a professional survey research firm. To be eligible, men or women had to live in SC for the majority of the year; be of screening age; have no hearing, speaking or cognitive difficulties that would preclude completion of the telephone interview; and had to speak and understand English. If eligible respondents agreed to participate, they were asked a series of questions to confirm their understanding of what was expected of them and that participation was voluntary. This standardized interview script for obtaining informed consent is routinely used in telephone-based survey research and was approved by the University for South Carolina's Institutional Review Board (SC, USA) [4]. Previously, using the same randomly-digit dialed telephone survey, Brandt *et al.* found that increased CRC awareness and knowledge scores were statistically significantly associated with any CRC test (i.e., FOBT, flexible sigmoidoscopy or colonoscopy) [4]. For the current analysis, there were a total of 1532 total respondents (36.6% response rate) with 29 partially completed interviews that were excluded. After restricting the analysis to only EAs and AAs, which was self-reported, the final sample size of respondents with complete information for exposures and outcomes was 1237. This SC population represents a medically underserved population in which to examine participation in CRC screening, especially among AAs. Additional details on methodology are reported elsewhere [4].

• Interview instrument & process

The instrument consisted of 144 self-reported questions assessing general health, awareness, knowledge and attitudes towards CRC screening, symptoms associated with increased CRC risk, past CRC and other cancer screening participation, exposure to CRC and screening information, access to healthcare and sociodemographic information. The instrument, which utilized questions previously used in cancer prevention and control throughout the nation and in SC, was developed based on a systematic literature review, external expert review and multiphase testing [4].

• Measures

The primary independent variables included participation in Pap tests, clinical breast examinations and mammograms for women, and PSA and DRE tests for men. Specifically, respondents were asked to recall their participation in these cancer screenings within the past 12 months. Possible responses to each cancer screening test included 'yes', 'no', 'don't know' or 'refused'. Responses of 'don't know and 'refused' were removed from the analyses. Each cancer screening test was analyzed individually, as well as combined to create an 'any cancer screening' measure for men and women separately.

The main dependent variables were adherence to participation for each form of CRC screening (i.e., FOBT, flexible sigmoidoscopy and/or colonoscopy), as well as adherence to any form of CRC screening. Adherence was calculated using the participant's current age, age at first screening and the screening type in the following equation, which was modified to fit each CRC screening test: If (current age) ≤ (age at first test + [number of lifetime tests × number of years recommended between tests]) then the person was adherent. Self-reported 'ever participating' in any CRC screening test was also modeled as an outcome. Potential covariate data included urban/rural status, family/friend history of CRC, tobacco use, diet, health insurance, sociodemographic factors, access to healthcare, and several scores related to awareness, attitudes and knowledge of CRC that have been previously described [4].

• Statistical analyses

Data were analyzed using SAS (version 9.3, NC, USA). χ^2 tests for categorical variables and t-tests or Wilcoxon rank sums test for continuous variables were used to compare descriptive population characteristics by race among men and women separately. Logistic regression variable selection procedures were based on a series of bivariate analyses (i.e., exposure plus confounder). Variables were selected for further evaluation as potential confounders if their statistical significance was $p \leq 0.20$. A backward elimination procedure was used to develop final

models that included all variables that were statistically significant ($\alpha \leq 0.05$) or, when removed from the model, changed the odds ratio of the primary independent variable by at least 10%. Rural/urban status was forced into all models due to the strong association between rural/urban status and CRC screening [35,36]. In addition, for several potentially important confounders (i.e., insurance, CRC awareness and knowledge scores) there was >10% missing information. These variables were not included in the variable selection procedure. However, a sensitivity analysis for additional adjustment of these factors had little effect on the interpretability of the statistically significant findings. Unconditional, fixed-effects logistic regression was used to calculate the adjusted odds ratio (aOR) and 95% CIs for the relationships between CRC screening or adherence and other cancer screenings after adjustment. By nature of the cancer screening tests, all analyses were stratified by sex. We additionally stratified all analyses by race.

Results

Overall, the respondents were primarily women (64%), EAs (79%), current or former smokers (57%), married (61%), older (mean age: 62.3 ± 7.2 years), overweight (mean BMI: 28.4 ± 5.9), obtained at least some college education (58%) or lived in urban areas (65%). There were several noticeable differences in population characteristics between EAs and AAs for both men and women **(Table 1)**. EAs were more likely to have an undergraduate or graduate degree, have an income above US$50,000, be married, perceive their health as excellent or very good, drive themselves to healthcare, and to have higher CRC knowledge, awareness and attitude scores (all p-values ≤0.01) than AAs. Among men only, EAs were more likely to be employed than AAs (p = 0.01). EA women were more likely to live in urban areas, formerly or currently smoke, know someone with CRC, be older and have a lower BMI compared with AA women.

Table 2 displays the main results for men only. The odds of any prostate cancer screening test, PSA or DRE were 1.68 (95% CI: 1.05–2.66), 2.05 (95% CI: 1.23–3.41) and 1.94 (95% CI: 1.20–3.13), respectively, times greater among all men who were adherent to any CRC screening test compared with those who were not. Similar observations were noted for adherence to colonoscopy among all men. Among EA men, the odds of having a PSA test was 1.87 (95% CI: 1.07–3.80) times greater among those who underwent a colonoscopy compared with those who did not. Additionally, PSA and DRE tests were statistically significantly associated with adherence to any CRC screening test. After adjustment, the only statistically significant association observed among AA men was between any prostate cancer test (i.e., PSA or DRE) and adherence to colonoscopies (aOR: 3.36; 95% CI: 1.04–10.17).

Statistically significant associations among all women mirrored findings among the EA female subgroup **(Table 3)**. Among EA women, the odds of having undergone any cervical or breast cancer screening test was 3.23 (95% CI: 1.88–5.56) times more likely among those who had ever been screened for CRC compared with those who had not been screened for CRC. A similar relationship was observed individually for the clinical breast examinations and mammograms. For adherence to colonoscopy, we observed positive statistically significant associations for any cervical or breast screening examination (aOR: 2.33; 95% CI: 1.41–3.84), as well as individually for clinical breast examination (aOR: 1.82; 95% CI: 1.14–2.89) and mammography (aOR: 2.61; 95% CI: 1.49–3.57). Similar findings were observed for adherence to any CRC screening test. Among AA women, the odds of a mammography was 2.26 (95% CI: 1.07–4.74) times greater among those adhering to any CRC screening test compared with those who did not **(Table 3)**. No other statistically significant associations were seen among AA women.

Discussion

This study examined the relationship between CRC screening and screening for other types of cancer (i.e., breast, cervical or prostate). Most statistically significant results were restricted to EA women, which were similar to findings observed among all women. Specifically, breast and cervical cancer screenings were associated with any previous CRC screening, as well as adherence to CRC screening. Mammography usage among AA women was also associated with greater adherence to colonoscopy screening. Our results among EA women were fairly consistent with previous research, although few of these studies exclusively examined EA or AA women [7,17,29,33]. For example, in a study by Carlos *et al.*, both Pap test (aOR: 2.40; 95% CI: 1.26–4.55) and mammography (aOR: 3.42; 95% CI: 1.79–6.51) utilization predicted

Table 1. Descriptive statistics and other selected covariates by sex and race.

Variable	Men; n (%)			Women; n (%)		
	European–American (n = 371)	*African–American (n = 79)*	*p-value*	*European–American (n = 603)*	*African–American (n = 184)*	*p-value*
Education; n (%):			<0.01			<0.01
– <High school	49 (13)	19 (25)		66 (11)	33 (18)	
– High school	83 (22)	24 (31)		169 (28)	69 (38)	
– Some college or associates degree	105 (28)	26 (34)		200 (33)	42 (23)	
– Undergraduate degree	68 (18)	6 (8)		101 (17)	25 (14)	
– Graduate degree	64 (17)	2 (3)		66 (11)	13 (7)	
Employment status; n (%):			0.01			0.91
– Employed	181 (49)	25 (32)		209 (35)	62 (34)	
– Not employed	190 (51)	53 (58)		393 (65)	119 (66)	
Income; n (%):			<0.01			<0.01
– <US$25,000	54 (15)	32 (41)		132 (22)	89 (48)	
– US$25,000–49,999	82 (22)	19 (24)		153 (25)	43 (23)	
– US$50,000–74,999	73 (20)	9 (11)		86 (14)	15 (8)	
– US$75,000+	115 (31)	8 (10)		113 (19)	10 (5)	
– Don't know or refuse	47 (13)	11 (14)		119 (20)	27 (15)	
Marital status; n (%):			<0.01			<0.01
– Married	277 (75)	45 (58)		363 (60)	71 (39)	
– Single or divorced	63 (17)	28 (36)		110 (18)	61 (34)	
– Widowed	30 (8)	5 (6)		128 (21)	49 (27)	
Location; n (%)			0.16			0.01
– Rural	124 (33)	33 (42)		196 (33)	79 (43)	
– Urban	247 (67)	46 (58)		407 (68)	105 (57)	
Perceived health; n (%):			<0.01			0.01
– Excellent	51 (14)	1 (1)		84 (14)	19 (10)	
– Very good	137 (37)	19 (24)		180 (30)	38 (21)	
– Good	110 (30)	27 (34)		207 (35)	75 (41)	
– Fair or poor	73 (20)	32 (41)		127 (21)	52 (28)	
Smoking status; n (%):			0.79			<0.01
– Current or former	254 (71)	54 (69)		288 (51)	58 (37)	
– Never	105 (29)	24 (31)		276 (49)	98 (63)	
Colonoscopy next 10 years[†]; n (%):			0.09			0.02
– Yes	288 (78)	55 (70)		467 (77)	151 (82)	
– No	58 (16)	13 (16)		96 (16)	15 (8)	
– Don't know	25 (7)	11 (14)		40 (7)	18 (10)	
Know someone with CRC[‡]; n (%)			0.46			0.01
– Yes	207 (56)	41 (52)		361 (60)	91 (50)	
– No	160 (44)	38 (48)		237 (40)	91 (50)	
Develop CRC in the future[§]; n (%):			<0.01			<0.01
– Very or somewhat likely	133 (36)	34 (43)		202 (34)	70 (38)	
– Somewhat unlikely	131 (35)	11 (14)		214 (35)	40 (22)	
– Very unlikely	89 (24)	21 (27)		139 (23)	51 (28)	
– Don't know	18 (5)	13 (16)		48 (8)	23 (13)	
Transportation to healthcare[¶]; n (%):			<0.01			<0.01
– Drive	330 (95)	54 (77)		515 (91)	123 (73)	
– Other transportation	19 (5)	16 (23)		49 (9)	45 (27)	

Frequencies may not equal column total due to missing data. Column percentages may not equal 100% due to rounding. χ^2 tests were used for comparison of categorical variables. T-tests or Wilcoxon rank sums tests were used for comparison of continuous measures.

[†]'Do you plan to have a colonoscopy in the next 10 years?'.

[‡]'Has anyone you know ever been diagnosed with colon cancer?'.

[§]'How likely do you think it is you will develop colon cancer in the future?'.

[¶]'How do you usually get to your healthcare provider?'.

[#]Higher scores indicate a greater knowledge or awareness of CRC, or a more positive attitude toward CRC screening.

CRC: Colorectal cancer.

Table 1. Descriptive statistics and other selected covariates by sex and race (cont.).

Variable	Men; n (%)			Women; n (%)		
	European–American (n = 371)	*African–American (n = 79)*	*p-value*	*European–American (n = 603)*	*African–American (n = 184)*	*p-value*
Age (mean ± standard deviation)	62.1 ± 7.1	62.1 ± 7.5	0.94	63.0 ± 7.1	60.6 ± 7.0	<0.01
BMI (mean ± standard deviation)	28.7 ± 5.0	27.8 ± 5.1	0.16	27.5 ± 6.2	30.7 ± 6.5	<0.01
Knowledge score[#] (mean ± standard deviation)	11.0 ± 2.3	9.7 ± 2.6	<0.01	10.6 ± 2.1	9.6 ± 2.6	<0.01
Awareness score[#] (mean ± standard deviation)	3.0 ± 1.3	2.3 ± 1.4	<0.01	3.3 ± 1.2	2.4 ± 1.5	<0.01
Attitude score[#] (mean ± standard deviation)	11.2 ± 2.7	12.1 ± 3.0	0.01	11.0 ± 2.7	12.1 ± 2.8	<0.01

Frequencies may not equal column total due to missing data. Column percentages may not equal 100% due to rounding. χ^2 tests were used for comparison of categorical variables. T-tests or Wilcoxon rank sums tests were used for comparison of continuous measures.
[†]'Do you plan to have a colonoscopy in the next 10 years?'.
[‡]'Has anyone you know ever been diagnosed with colon cancer?'.
[§]'How likely do you think it is you will develop colon cancer in the future?'.
[¶]'How do you usually get to your healthcare provider?'.
[#]Higher scores indicate a greater knowledge or awareness of CRC, or a more positive attitude toward CRC screening.
CRC: Colorectal cancer.

any CRC screening adherence [7]. Among AA women, Reiter *et al.* found that those who reported a mammogram within the last year were more likely to be within any recommended CRC screening guidelines (aOR: 3.25; 95% CI: 1.28–8.28) [28]; whereas, the current study revealed mammography to be associated with only colonoscopy adherence among AA women. Our findings reveal potential racial disparities as they relate to CRC screening, which may partially explain racial disparities in CRC. According to the American Cancer Society, the incidence and mortality from CRC was higher among both male and female AAs compared with EAs [8]. Partially due to these known racial disparities in CRC, the American College of Gastroenterology currently recommends that AAs begin CRC screening at the of age 45 years [37].

Regardless of race, we did not find breast or cervical cancer screening to be associated with FOBT or flexible sigmoidoscopy among female participants, which is inconsistent with previous research [30–31,38]. One possibility for this inconsistency is the limited sample size in the current study. Among female participants, numerous odds ratios were >1.0 for FOBT and flexible sigmoidoscopy, but the CIs were wide and insignificant. In addition, small sample sizes among AA women may partially explain the lack of statistical significance among this group, as aORs were of similar magnitude as EA women. We observed stronger associations between breast and CRC screening than for cervical and CRC screening. One possible explanation for this is that mammography and CRC both often require a visit beyond one's primary care provider and these women may be more likely to adhere to multiple tests [5].

Among all men, our results were somewhat consistent with previous research [33,39–40], although there was inconsistency between EAs and AAs. We observed associations between PSA or DRE and adherence to any CRC screening test or adherence to colonoscopy, specifically, among all men. Carlos and colleagues found adherence to PSA (aOR: 3.24; 95% CI: 3.06–3.44) or DRE (aOR: 3.82; 95% CI: 3.60–4.06) were the strongest predictors of any CRC screening adherence using BRFSS data [16]. Haque and colleagues found that men who did not partake in PSA screening were statistically significantly less likely to partake in flexible sigmoidoscopy screening compared with those who did undergo PSA screening (aOR: 0.59; 95% CI: 0.56–0.63) [39], a result not observed in this study. Results among AA men may have been subject to reduced power due to limited sample sizes indicated by odds ratios >1.0, but imprecise and wide CIs.

Advantages of this study included use of men and women, as well as stratification by race. Few previous studies have exclusively focused on or stratified results by EAs and/or AAs [28]. Additionally, we analyzed participation in several CRC screening tests including, FOBT, flexible sigmoidoscopy and colonoscopies. We compared these CRC screening tests to numerous other cancer screening tests (mammography, clinical breast examination, Pap test, PSA and DRE), which is more inclusive than previous studies. The use of a SC population is unique

considering that SC ranks in the highest quartile of healthcare quality, but ranks among states with the largest income-related disparities in healthcare quality [41]. We were able to screen many known or suspected factors associated with cancer screening including, but not limited to, age, BMI, income, education, marital status, tobacco use, urbanicity, concerns/beliefs about CRC screening, knowledge/awareness of CRC, primary means of travel, healthcare utilization and insurance.

This study was subject to several limitations. The cross-sectional nature of this study precludes causation and it was not possible to determine if breast, cervical or prostate cancer screenings occurred prior to or after CRC screening or the direction of the relationship. Breast, cervical and prostate cancer screening participation was only obtained for the previous 12 months; whereas, CRC screening participation was obtained based on the recommended number of years between CRC screening tests. Of particular concern is bias related to Pap tests among women with a hysterectomy. The CDC and the US Preventive Services Task Force only recommends cervical cancer screening for women who have had a hysterectomy if they have a history of invasive cervical disease [42]. Information on hysterectomy procedures and reason for hysterectomy were not obtained. Additionally, there is concern for recall bias due to the self-report nature of the interview. Although the sampling rate (36.6%) was similar to other computer-assisted telephone interviews [43], information on nonresponders was not collected and therefore could not be compared with responders. Telephone interviewing protocols have inherent limitations [43,44], but methods were used to maximize participation, which have been described elsewhere [4]. Lastly, only AAs and EAs were examined; other minority groups were excluded due to small sample sizes.

Considering participation in breast and cervical cancer screening is greater than CRC screening participation [45], breast and cervical cancer

Table 2. Association between colorectal cancer-related screening and other cancer screening tests among men.

Cancer screening test	All men		European–American		African–American	
	Crude OR (95% CI)	*Adjusted OR (95% CI)*	*Crude OR (95% CI)*	*Adjusted OR (95% CI)*	*Crude OR (95% CI)*	*Adjusted OR (95% CI)*
Ever participating in any CRC screen test						
Any cancer test	2.62 (1.64–4.19)	1.63 (0.98–2.74)	2.71 (1.61–4.55)	1.77 (0.99–3.14)	2.26 (0.76–6.75)	1.44 (0.41–5.06)
PSA	1.95 (1.14–3.32)	1.39 (0.78–2.48)	2.17 (1.19–3.97)	1.62 (0.84–3.19)	1.20 (0.38–3.98)	0.85 (0.23–3.19)
DRE	3.20 (1.97–5.20)	2.06 (1.21–3.51)	3.28 (1.92–5.61)	2.13 (1.18–3.85)	2.82 (0.87–9.16)	1.90 (0.52–7.02)
Adherence to colonoscopy						
Any cancer test	2.76 (1.85–4.12)	1.71 (1.08–2.72)	2.54 (1.63–3.97)	1.44 (0.85–2.44)	3.67 (1.44–9.36)	3.36 (1.04–10.17)
PSA	2.43 (1.57–3.75)	1.87 (1.14–3.07)	2.55 (1.56–4.15)	1.87 (1.07–3.80)	2.00 (0.75–5.35)	1.42 (0.44–4.52)
DRE	2.74 (1.83–4.10)	1.79 (1.19–2.87)	2.65 (1.70–4.14)	1.60 (0.94–2.73)	2.90 (1.12–7.51)	3.21 (0.96–10.75)
Adherence to flexible sigmoidoscopy						
Any cancer test	0.97 (0.57–1.64)	1.04 (0.61–1.77)	0.75 (0.41–1.39)	0.75 (0.40–1.38)	2.33 (0.79–6.86)	2.17 (0.72–6.56)
PSA	1.14 (0.67–1.96)	1.22 (0.70–2.10)	1.06 (0.56–2.00)	1.06 (0.56–2.00)	1.53 (0.53–4.42)	1.38 (0.47–4.08)
DRE	0.90 (0.53–1.54)	0.98 (0.57–1.68)	0.81 (0.43–1.53)	0.81 (0.43–1.52)	1.48 (0.52–4.26)	1.41 (0.48–4.15)
Adherence to fecal occult blood test						
Any cancer test	1.48 (0.69–3.15)	1.59 (0.71–3.55)	1.77 (0.73–4.25)	1.82 (0.73–4.54)	0.74 (0.14–3.91)	–
PSA	1.99 (0.99–4.03)	1.89 (0.91–3.91)	1.96 (0.90–4.24)	1.85 (0.83–4.11)	2.18 (0.41–11.68)	–
DRE	2.00 (0.91–4.41)	2.20 (0.95–5.10)	2.11 (0.87–5.11)	2.23 (0.88–5.61)	1.50 (0.24–9.55)	–
Adherence to any CRC screening test						
Any cancer test	2.59 (1.72–3.90)	1.68 (1.05–2.66)	2.37 (1.50–3.74)	1.52 (0.90–2.57)	3.48 (1.35–8.97)	2.85 (0.88–9.20)
PSA	2.58 (1.62–4.11)	2.05 (1.23–3.41)	2.66 (1.58–4.49)	2.07 (1.17–3.67)	2.29 (0.82–6.41)	1.79 (0.50–6.41)
DRE	2.75 (1.82–4.17)	1.94 (1.20–3.13)	2.65 (1.67–4.20)	1.87 (1.10 -3.18)	3.02 (1.14–8.02)	2.72 (0.79–9.39)

Any CRC screening adjusted for age, plan on colonoscopy in next 10 years, health insurance, urban vs rural status and CRC awareness and attitude scores. Adherence to colonoscopy adjusted for age, plan on colonoscopy in next 10 years, know someone with CRC, employment status, income, urban vs rural status and CRC awareness and attitude scores. Adherence to flexible sigmoidoscopy adjusted for age and urban vs rural status. Adherence to fecal occult blood test adjusted for age, concern for CRC development, transportation means to clinic and urban vs rural status. Adherence to any CRC screening test adjusted for age, plan on colonoscopy in next 10 years, know someone with CRC, urban vs rural status, and CRC awareness, knowledge and attitude scores.
–: Validity of model fit was questionable due to limited sample sizes. Any cancer test refers to any prostate cancer test (i.e., DRE or PSA); CRC: Colorectal cancer; DRE: Digital rectal examination; OR: Odds ratio; PSA: Prostate-specific antigen.

Table 3. Association between colorectal cancer-related screening and other cancer screening tests among women.

Cancer screening test	All women		European–American		African–American	
	Crude OR (95% CI)	*Adjusted OR (95% CI)*	*Crude OR (95% CI)*	*Adjusted OR (95% CI)*	*Crude OR (95% CI)*	*Adjusted OR (95% CI)*
Ever participating in any CRC screen test						
Any cancer test	4.06 (2.71–6.10)	2.96 (1.85–4.71)	4.34 (2.71–6.96)	3.23 (1.88–5.56)	3.38 (1.51–7.58)	2.24 (0.88–5.75)
Pap smear	1.53 (1.07–2.20)	1.56 (1.03–2.37)	1.45 (0.95–2.21)	1.39 (0.85–2.27)	1.89 (0.94–3.80)	2.10 (0.90–4.91)
Breast examination	3.14 (2.13–4.61)	2.52 (1.63–3.91)	3.61 (2.31–5.64)	2.85 (1.71–4.73)	2.10 (0.97–4.52)	1.68 (0.68–4.15)
Mammography	3.38 (2.32–4.92)	2.26 (1.49–3.44)	3.72 (2.39–5.78)	2.53 (1.55–4.12)	2.61 (1.26–5.41)	1.76 (0.75–4.15)
Adherence to colonoscopy						
Any cancer test	3.06 (2.10–4.46)	2.15 (1.40–3.30)	3.11 (2.01–4.79)	2.33 (1.41–3.84)	3.05 (1.40–6.68)	1.90 (0.78–4.65)
Pap smear	1.43 (1.06–1.93)	1.40 (0.98–1.99)	1.45 (1.02–2.06)	1.42 (0.93–2.15)	1.51 (0.83–2.74)	1.34 (0.67–2.68)
Breast examination	2.08 (1.47–2.92)	1.56 (1.05–2.32)	2.33 (1.57–3.46)	1.82 (1.14–2.89)	1.50 (0.76–2.99)	1.12 (0.50–2.52)
Mammography	3.07 (2.21–4.27)	2.13 (1.47–3.09)	3.25 (2.21–4.77)	2.61 (1.49–3.57)	2.70 (1.39–5.24)	2.07 (0.96–4.45)
Adherence to flexible sigmoidoscopy						
Any cancer test	1.37 (0.74–2.54)	1.54 (0.82–2.90)	1.11 (0.54–2.26)	1.18 (0.69–2.02)	2.38 (0.68–8.33)	2.36 (0.67–8.29)
Pap smear	1.30 (0.83–2.03)	1.37 (0.87–2.17)	1.15 (0.68–1.97)	1.19 (0.68–2.07)	1.61 (0.71–3.65)	1.60 (0.70–3.62)
Breast examination	1.39 (0.80–2.43)	1.52 (0.87–2.68)	1.24 (0.64–2.41)	1.24 (0.64–2.41)	1.83 (0.66–5.10)	1.81 (0.65–5.05)
Mammography	1.23 (0.74–2.03)	1.32 (0.79–2.21)	1.04 (0.57–1.90)	1.05 (0.58–1.92)	1.82 (0.70–4.73)	1.82 (0.35–4.74)
Adherence to fecal occult blood test						
Any cancer test	2.56 (1.01–6.51)	2.03 (0.78–5.27)	4.99 (1.19–20.92)	3.84 (0.90–16.37)	0.94 (0.25–3.51)	0.80 (0.20–3.17)
Pap smear	1.48 (0.86–2.55)	1.32 (0.76–2.29)	1.43 (0.76–2.66)	1.22 (0.64–2.30)	1.63 (0.54–4.89)	1.51 (0.49–4.69)
Breast examination	2.13 (0.99–4.57)	1.81 (0.83–3.96)	3.34 (1.18–9.49)	2.79 (0.96–8.10)	0.92 (0.28–3.02)	0.84 (0.24–3.89)
Mammography	1.57 (0.82–3.02)	1.33 (0.68–2.59)	2.54 (1.06–6.12)	2.11 (0.86–5.18)	0.61 (0.21–1.77)	0.53 (0.17–1.61)
Adherence to any CRC screening test						
Any cancer test	3.57 (2.44–5.22)	2.60 (1.69–3.99)	3.82 (2.46–5.92)	2.93 (1.77–4.86)	3.00 (1.39–6.49)	2.15 (0.91–5.07)
Pap smear	1.60 (1.17–2.19)	1.59 (1.11–2.28)	1.61 (1.11–2.31)	1.59 (1.03–2.45)	1.72 (0.93–3.17)	1.55 (0.78–3.07)
Breast examination	2.49 (1.75–3.52)	1.93 (1.30–2.87)	2.90 (1.94–4.35)	2.31 (1.45–3.70)	1.60 (0.80–3.22)	1.32 (0.60–2.89)
Mammography	3.51 (2.50–4.91)	2.50 (1.72–3.64)	3.87 (2.61–5.74)	2.81 (1.80–4.39)	2.71 (1.40–5.27)	2.26 (1.07–4.74)

Any cancer test refers to any cervical or breast cancer test (i.e., Pap smear, clinical breast examination or mammography). Any CRC screening adjusted for age, plan on colonoscopy in next 10 years, health insurance, urban vs rural status and CRC awareness and attitude scores. Adherence to colonoscopy adjusted for age, plan on colonoscopy in next 10 years, know someone with CRC, employment status, income, urban vs rural status and CRC awareness and attitude scores. Adherence to flexible sigmoidoscopy adjusted for age and urban vs rural status. Adherence to fecal occult blood test adjusted for age, concern for CRC development, transportation means to clinic and urban vs rural status. Adherence to any CRC screening test adjusted for age, plan on colonoscopy in next 10 years, know someone with CRC, urban vs rural status, and CRC awareness, knowledge and attitude scores.
CRC: Colorectal cancer; OR: Odds ratio.

screening tests may serve as 'teachable moments' to increase education of and participation in CRC screening. Carlos and colleagues suggest that an educational intervention for CRC screening that occurs at the time of other cancer screening tests may increase the effectiveness of the educational intervention. This, in turn, may increase participation in CRC screening [34]. Although BRFSS data indicate that CRC screening adherence is greater than prostate cancer adherence [6,45], PSA or DRE test visits can still be used as 'teachable moments'. We further postulate that these 'teachable moments' may help to partially address racial disparities in CRC and CRC screening by helping to overcome CRC screening barriers, especially among AAs. These barriers include, but are not limited to, socioeconomic status, access to healthcare, regular contact with the medical system, lack of health insurance, physician recommendation and fatalistic views and knowledge about cancer screening [4,26,46–59]. These teachable moments may especially help to overcome racial barriers to CRC screening related to fatalist views or lack of knowledge and awareness about CRC. Additionally, coupling these 'teachable moments' with culturally targeted interventions, which have been shown to increase CRC screening participation [57,60–63], may further increase participation in CRC screening among minority populations.

Another approach to increasing CRC screening is through 'one-stop-shopping' for cancer screening [64]. The Integrated Cancer Prevention Center at the Tel Aviv Sourasky Medical Center (Tel Aviv, Israel) developed a protocol to test

for colorectal, lung, breast, skin, prostate, ovary, uterine, cervix, testicular, oral and thyroid cancers. Tests for each of these cancers, excluding colonoscopies, were conducted on a single visit. This study found increased participation for numerous cancer screening tests compared with the general population of Israel [64]. Specifically for CRC, Sella *et al.* found that the 'one-stop-shopping' protocol increased colonoscopy participation by ≈144% compared with the general Israeli population (39 vs 16%) [64].

Conclusion & future perspective

CRC screening is vitally important for reduction of CRC incidence and mortality, as CRC screening can be a form of primary cancer prevention [8]. Cancer screening tests (e.g., mammography, clinical breast examination, Pap test, PSA and DRE) may help to promote CRC screening either through teaching moments or one-stop-shopping. This may specifically address barriers to CRC screening among AAs by increasing knowledge and awareness of CRC and through increasing access to cancer screenings, especially if these protocols are culturally appropriate. Future research should elucidate the relationships between CRC screening and other cancer screenings, especially among minority populations, in terms of temporality. Additionally, 'teachable moments' or 'one-stop-shopping' interventions should be developed and applied among minority populations, such as AAs in southeastern USA, to determine if these protocols can overcome racial barriers to CRC screening.

Disclaimer

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

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Ethical conduct of research

The authors state that they have obtained appropriate institutional review board approval or have followed the principles outlined in the Declaration of Helsinki for all human or animal experimental investigations. In addition, for investigations involving human subjects, informed consent has been obtained from the participants involved.

References

Papers of special note have been highlighted as:
• of interest

1 Siegel R, Naishadham D, Jemal A. Cancer statistics, 2013. *CA Cancer J. Clin.* 63(1), 11–30 (2013).

2 US Preventive Services Task Force. Screening for colorectal cancer: U.S. Preventive Services Task Force recommendation statement. *Ann. Intern. Med.* 149(9), 627–637 (2008).

3 Smith RA, Brooks D, Cokkinides V, Saslow D, Brawley OW. Cancer screening in the United States, 2013: a review of current american cancer society guidelines, current issues in cancer screening, and new guidance on cervical cancer screening and lung cancer screening. *CA Cancer J. Clin.* 63(2), 87–105 (2013).

4 Brandt HM, Dolinger HR, Sharpe PA, Hardin JW, Berger FG. Relationship of colorectal cancer awareness and knowledge with colorectal cancer screening. *Colorectal Cancer* 1(5), 383–396 (2012).

• **Study provides the methodology for the random digit-dialed telephone survey utilized in this study.**

5 Ellison J, Jandorf L, Villagra C, Winkel G, Duhamel K. Screening adherence for colorectal cancer among immigrant Hispanic women. *J. Natl Med. Assoc.* 103(8), 681–688 (2011).

6 Joseph DA, King JB, Miller JW, Richardson LC; Centers for Disease Control and Prevention. Prevalence of colorectal cancer screening among adults - Behavioral Risk Factor Surveillance System, United States, 2010. *MMWR Morb. Mortal. Wkly Rep.* 61(Suppl. 2), 51–56 (2012).

7 Carlos RC, Fendrick AM, Patterson SK, Bernstein SJ. Associations in breast and colon cancer screening behavior in women. *Acad. Radiol.* 12(4), 451–458 (2005).

• **One of the first studies to show an association between breast and colon cancer screening among women. The authors proposed using breast cancer screenings as 'teachable moments' for colorectal cancer screening.**

8 American Cancer Society. Cancer prevention and early detection facts and figures 2012. www.cancer.org/acs/groups/content/@epidemiologysurveilance/documents/document/acspc-033423.pdf

9 Cancer Trends Progress Report: 2011/2012 Update, National Cancer Institute, NIH, DHHS, Bethesda, MD, USA (August 2012). http://progressreport.cancer.gov/doc_detail.asp?pid=1&did=2007&chid=72&coid=718

10 Colorectal cancer tests save lives. www.cdc.gov/vitalsigns/colorectalcancerscreening

11 American Cancer Society. Cancer facts and figures 2012. www.cancer.org/acs/groups/content/@epidemiologysurveilance/documents/document/acspc-031941.pdf

12 Wagner SE, Hurley DM, Hebert JR, Mcnamara C, Bayakly AR, Vena JE. Cancer

mortality-to-incidence ratios in Georgia: describing racial cancer disparities and potential geographic determinants. *Cancer* 118(16), 4032–4045 (2012).

13 Meissner HI, Breen N, Klabunde CN, Vernon SW. Patterns of colorectal cancer screening uptake among men and women in the United States. *Cancer Epidemiol. Biomarkers Prev.* 15(2), 389–394 (2006).

14 Richards RJ, Reker DM. Racial differences in use of colonoscopy, sigmoidoscopy, and barium enema in Medicare beneficiaries. *Dig. Dis. Sci.* 47(12), 2715–2719 (2002).

15 Hebert JR, Daguise VG, Hurley DM *et al.* Mapping cancer mortality-to-incidence ratios to illustrate racial and sex disparities in a high-risk population. *Cancer* 115(11), 2539–2552 (2009).

- **Displays the racial disparities in colorectal cancer through examining the mortality-to-incidence in the state of South Carolina (USA).**

16 Carlos RC, Underwood W 3rd, Fendrick AM, Bernstein SJ. Behavioral associations between prostate and colon cancer screening. *J. Am. Coll. Surg.* 200(2), 216–223 (2005).

- **One of the first studies to show an association between prostate and colon cancer screening among men.**

17 Guerrero-Preston R, Chan C, Vlahov D, Mitchell MK, Johnson SB, Freeman H. Previous cancer screening behavior as predictor of endoscopic colon cancer screening among women aged 50 and over, in NYC 2002. *J. Community Health* 33(1), 10–21 (2008).

18 Christie J, Hooper C, Redd WH *et al.* Predictors of endoscopy in minority women. *J. Natl Med. Assoc.* 97(10), 1361–1368 (2005).

19 Purnell JQ, Katz ML, Andersen BL *et al.* Social and cultural factors are related to perceived colorectal cancer screening benefits and intentions in African Americans. *J. Behav. Med.* 33(1), 24–34 (2010).

20 Klabunde CN, Schenck AP, Davis WW. Barriers to colorectal cancer screening among Medicare consumers. *Am. J. Prev. Med.* 30(4), 313–319 (2006).

21 Griffith KA. Biological, psychological and behavioral, and social variables influencing colorectal cancer screening in African Americans. *Nurs. Res.* 58(5), 312–320 (2009).

22 Katz ML, James AS, Pignone MP *et al.* Colorectal cancer screening among African American church members: a qualitative and quantitative study of patient–provider communication. *BMC Public Health* 4, 62 (2004).

23 Taylor V, Lessler D, Mertens K *et al.* Colorectal cancer screening among African Americans: the importance of physician recommendation. *J. Natl Med. Assoc.* 95(9), 806–812 (2003).

24 Wilkins T, Gillies RA, Harbuck S, Garren J, Looney SW, Schade RR. Racial disparities and barriers to colorectal cancer screening in rural areas. *J. Am. Board Fam. Med.* 25(3), 308–317 (2012).

25 Ruggieri DG, Bass SB, Rovito MJ *et al.* Perceived colonoscopy barriers and facilitators among urban African American patients and their medical residents. *J. Health Commun.* 18(4), 372–390 (2013).

26 Guessous I, Dash C, Lapin P, Doroshenk M, Smith RA, Klabunde CN. Colorectal cancer screening barriers and facilitators in older persons. *Prev. Med.* 50(1–2), 3–10 (2010).

27 Gonzalez P, Castaneda SF, Mills PJ, Talavera GA, Elder JP, Gallo LC. Determinants of breast, cervical and colorectal cancer screening adherence in Mexican–American women. *J. Commun. Health* 37(2), 421–433 (2012).

28 Reiter PL, Linnan LA. Cancer screening behaviors of African American women enrolled in a community-based cancer prevention trial. *J. Womens Health (Larchmt)* doi:10.1089/jwh.2010.2245 (2011) (Epub ahead of print).

29 Sinicrope PS, Goode EL, Limburg PJ *et al.* A population-based study of prevalence and adherence trends in average risk colorectal cancer screening, 1997 to 2008. *Cancer Epidemiol. Biomarkers Prev.* 21(2), 347–350 (2012).

30 McGregor SE, Bryant HE. Predictors of colorectal cancer screening: a comparison of men and women. *Can. J. Gastroenterol.* 19(6), 343–349 (2005).

31 Shapiro JA, Seeff LC, Nadel MR. Colorectal cancer-screening tests and associated health behaviors. *Am. J. Prev. Med.* 21(2), 132–137 (2001).

32 Gorin SS, Heck JE. Cancer screening among Latino subgroups in the United States. *Prev. Med.* 40(5), 515–526 (2005).

33 Lemon S, Zapka J, Puleo E, Luckmann R, Chasan-Taber L. Colorectal cancer screening participation: comparisons with mammography and prostate-specific antigen screening. *Am. J. Public Health* 91(8), 1264–1272 (2001).

34 Carlos RC, Fendrick AM, Bernstein SJ. Can breast and cervical cancer screening visits be used to improve colorectal cancer screening? *J. Gen. Intern. Med.* 19, 127–127 (2004).

35 Anderson AE, Henry KA, Samadder NJ, Merrill RM, Kinney AY. Rural vs urban residence affects risk-appropriate colorectal cancer screening. *Clin. Gastroenterol. Hepatol.* 11(5), 526–533 (2013).

36 Cole AM, Jackson JE, Doescher M. Urban–rural disparities in colorectal cancer screening: cross-sectional analysis of 1998–2005 data from the Centers for Disease Control's Behavioral Risk Factor Surveillance study. *Cancer Med.* 1(3), 350–356 (2012).

37 Rex DK, Johnson DA, Anderson JC, Schoenfeld PS, Burke CA, Inadomi JM. American College of Gastroenterology guidelines for colorectal cancer screening 2009 [corrected]. *Am. J. Gastroenterol.* 104(3), 739–750 (2009).

38 O'donnell S, Goldstein B, Dimatteo MR, Fox SA, John CR, Obrzut JE. Adherence to mammography and colorectal cancer screening in women 50–80 years of age the role of psychological distress. *Womens Health Issues* 20(5), 343–349 (2010).

39 Haque R, Quinn VP, Habel LA *et al.* Correlates of screening sigmoidoscopy use among men in a large nonprofit health plan. *Cancer* 110(2), 275–281 (2007).

40 Carlos RC, Fendrick AM, Abrahamse PH, Dong Q, Patterson SK, Bernstein SJ. Colorectal cancer screening behavior in women attending screening mammography: longitudinal trends and predictors. *Womens Health Issues* 15(6), 249–257 (2005).

41 Agency for Healthcare Research and Quality. 2011 National Healthcare Quality and Disparities Reports. www.ahrq.gov/qual/qrdr11.htm

42 Kaplan JE, Benson C, Holmes KK *et al.* Guidelines for prevention and treatment of opportunistic infections in HIV-infected adults and adolescents: recommendations from CDC, the National Institutes of Health, and the HIV Medicine Association of the Infectious Diseases Society of America. *MMWR Recomm. Rep.* 58(RR-4), 1–207; quiz CE1–4 (2009).

43 O'Toole J, Sinclair M, Leder K. Maximising response rates in household telephone surveys. *BMC Med. Res. Methodol.* 8, 71 (2008).

44 Kempf AM, Remington PL. New challenges for telephone survey research in the twenty-first century. *Annu. Rev. Public Health* 28, 113–126 (2007).

45 Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System Survey. www.cdc.gov/brfss

46 Shavers VL, Jackson MC, Sheppard VB. Racial/ethnic patterns of uptake of colorectal screening, National Health Interview Survey 2000–2008. *J. Natl Med. Assoc.* 102(7), 621–635 (2010).

47 Jerant AF, Fenton JJ, Franks P. Determinants of racial/ethnic colorectal cancer screening disparities. *Arch. Intern. Med.* 168(12), 1317–1324 (2008).

48 Goy J, Rosenberg MW, King WD. Health risk behaviors: examining social inequalities in bladder and colorectal cancers. *Ann. Epidemiol.* 18(2), 156–162 (2008).

49 O'Malley AS, Forrest CB, Feng S, Mandelblatt J. Disparities despite coverage: gaps in colorectal cancer screening among Medicare beneficiaries. *Arch. Intern. Med.* 165(18), 2129–2135 (2005).

50 Seeff LC, Nadel MR, Klabunde CN *et al.* Patterns and predictors of colorectal cancer test use in the adult U.S. population. *Cancer* 100(10), 2093–2103 (2004).

51 Trivers KF, Shaw KM, Sabatino SA, Shapiro JA, Coates RJ. Trends in colorectal cancer screening disparities in people aged 50–64 years, 2000–2005. *Am. J. Prev. Med.* 35(3), 185–193 (2008).

52 Wee CC, McCarthy EP, Phillips RS. Factors associated with colon cancer screening: the role of patient factors and physician counseling. *Prev. Med.* 41(1), 23–29 (2005).

53 Datta GD, Colditz GA, Kawachi I, Subramanian SV, Palmer JR, Rosenberg L. Individual-, neighborhood-, and state-level socioeconomic predictors of cervical carcinoma screening among U.S. black women: a multilevel analysis. *Cancer* 106(3), 664–669 (2006).

54 Shokar NK, Carlson CA, Weller SC. Factors associated with racial/ethnic differences in colorectal cancer screening. *J. Am. Board Fam. Med.* 21(5), 414–426 (2008).

55 Brawarsky P, Brooks DR, Mucci LA, Wood PA. Effect of physician recommendation and patient adherence on rates of colorectal cancer testing. *Cancer Detect. Prev.* 28(4), 260–268 (2004).

56 Powe BD. Fatalism among elderly African Americans. Effects on colorectal cancer screening. *Cancer Nurs.* 18(5), 385–392 (1995).

57 Morgan PD, Fogel J, Tyler ID, Jones JR. Culturally targeted educational intervention to increase colorectal health awareness among African Americans. *J. Health Care Poor Underserved* 21(3 Suppl.), 132–147 (2010).

58 Shokar NK, Vernon SW, Weller SC. Cancer and colorectal cancer: knowledge, beliefs, and screening preferences of a diverse patient population. *Fam. Med.* 37(5), 341–347 (2005).

59 Lubetkin EI, Santana A, Tso A, Jia H. Predictors of cancer screening among low-income primary care patients. *J. Health Care Poor Underserved* 19(1), 135–148 (2008).

60 Powe BD, Faulkenberry R, Harmond L. A review of intervention studies that seek to increase colorectal cancer screening among African–Americans. *Am. J. Health Promot.* 25(2), 92–99 (2010).

61 Ward SH, Lin K, Meyer B *et al.* Increasing colorectal cancer screening among African Americans, linking risk perception to interventions targeting patients, communities and clinicians. *J. Natl Med. Assoc.* 100(6), 748–758 (2008).

62 Philip EJ, Duhamel K, Jandorf L. Evaluating the impact of an educational intervention to increase CRC screening rates in the African American community: a preliminary study. *Cancer Cause Control* 21(10), 1685–1691 (2010).

63 Sanders Thompson VL, Lewis T, Williams SL. Refining the use of cancer-related cultural constructs with African Americans. *Health Promot. Prac.* 14(1), 38–43 (2013).

64 Sella T, Boursi B, Gat-Charlap A *et al.* One stop screening for multiple cancers: the experience of an integrated cancer prevention center. *Eur. J. Intern. Med.* 24(3), 245–249 (2013).

- **Demonstrated increased colorectal cancer screening in response to a 'one-stop-shopping' protocol for cancer screenings.**