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Colorectal cancer screening utilization among breast, cervical, prostate, skin, and lung cancer survivors

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Abstract

Purpose To examine whether sociodemographic characteristics, access to care, risk behavior factors, and chronic health conditions were associated with colorectal cancer (CRC) screening utilization among breast, cervical, prostate, skin, and lung cancer survivors.

Methods We analyzed the 2020 Behavioral Risk Factor Surveillance System (BRFSS) data on 9780 eligible cancer survivors. Descriptive statistics and multivariable logistic regression models were applied to assess the association between guideline-concordant CRC screening and the mentioned characteristics.

Results Overall, 81.9%, 65%, 88%,78.1%, and 80.1% of breast, cervical, prostate, skin, and lung cancer survivors received CRC screening, respectively (p-value < 0.001). In multivariable analysis, breast, cervical, and skin cancer survivors aged 60 years or older were associated with higher odds of receiving CRC screening. Respondents that had their recency of routine checkup two or more years before had lower odds of having CRC screening among cervical (OR = 0.06; 95% CI, 0.02–0.22), prostate (OR = 0.26; 95% CI, 0.14–0.49), and skin cancer (OR = 0.50; 95% CI, 0.36–0.70) survivors. The presence of chronic diseases was also associated with guideline-concordant CRC screening among breast, prostate, and skin cancer survivors.

Conclusions Our findings provide important evidence on potential factors that are associated with guideline-concordant CRC screening utilization across different cancer survivors, which include older age, recency of routine checkup, and multiple chronic diseases. Moreover, variation in CRC screening utilization across cancer survivors may highlight missed opportunities for secondary cancer prevention.

Implications for Cancer Survivors Establishing clear CRC screening guidelines and including patient-provider communication on recommendation in cancer survivorship care may increase adherence to CRC screening.

Keywords Cancer survivors · Colorectal cancer screening · Behavioral risk factors · Health service factors

Introduction

Breast, cervical, prostate, melanoma of the skin, and lung cancers are the most common cancers among women and men in the United States (U.S.) [1]. Advancement in cancer detection and treatment has improved survival rates leading to a growing population of cancer survivors [2, 3]; however, cancer survivors are at a 20% increased risk of developing a secondary cancer [4]. Second cancers can reflect the carcinogenetic effects of cancer-related treatment (i.e., chemotherapy and radiation) [5–7], as well as the effect of lifestyle factors, environmental exposures, and shared etiologic factors [8, 9].

Previous studies among breast, cervical, prostate, and lung cancer survivors have reported an increased risk of second primary colorectal cancer (CRC) [5, 10–12]. Malignant melanoma was also considered to be the most common tumor metastasizing to the colon [13]. Accordingly, cancer survivors are recommended to have regular follow-up care with preventive screening for common cancers, such as CRC, one of the more preventable and treatable cancers, and the third most common cause of cancer and cancer death in the U.S. [1, 2, 14]. Therefore, adherence to CRC screening recommendation should be highly prioritized among cancer survivors.

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According to the American Cancer Society (ACS) and the U.S. Preventive Services Task Force (USPSTF) recommendation on CRC screening, adults aged 45–75 years should have a fecal occult blood test (FOBT) every year, flexible sigmoidoscopy every 5 year, and colonoscopy every 10 year [15, 16]. There were 71.6% of adults aged 50–74 years reported being guideline-concordant with CRC screening among average-risk US population in 2020 [17]. While several options for CRC screening exist [15, 16], CRC screening utilization across different cancer survivors remains varied. To date, much research regarding CRC screening among cancer survivors predominantly focuses on breast cancer [18–20] or CRC survivors (i.e., reoccurrence of CRC) [21]. A US study reported that 54% of prostate cancer survivors and 44% of breast cancer survivors received a colonoscopy [22]. Another study among Singaporean patients reported 46% and 54% of cancer survivors underwent FOBT and colonoscopy, respectively [23]. Compared to a sample of US women without a cancer history, breast cancer survivors were more likely to have a FOBT home test within the past year (24.6% vs. 19.1%) and an endoscopic exam within the past 10 years (57.2% vs. 42.9%) [20].

Considering the factors associated with CRC screening uptake, screening behaviors are likely mediated by sociodemographic characteristics (i.e., race/ethnicity, education, income, and rural areas), lifestyle choices (i.e., smoking status and alcohol consumption), family history of CRC, and influenced by health service factors linked to health insurance coverage and physician recommendation [20, 22, 23]. Cancer survivors with higher education, higher household income, family history of CRC, and those with physician recommendation were more likely to receive CRC screening [23, 24]. Non-Hispanic White (NHW) and Asian breast cancer survivors were more likely to receive endoscopic screening within the past 10 years [23]. Additionally, several cancer survivors reported visiting their primary care physicians (PCPs) for their continuing care [24], which makes physician recommendation a key factor of receiving screening. Given an increased risk of developing CRC among cancer survivors, having regular appointments with PCPs regarding CRC screening is necessary.

Although prior studies suggested that cancer survivors were more likely to receive CRC screening, the comparison of screening uptake across different types of cancer survivorship, such as cervical, skin, and lung cancers, has not been reported. Moreover, the factors in health service characteristics, risk behaviors, and multiple medical conditions affecting screening uptake have not been documented across different cancer types. To further the understanding of CRC screening behaviors among cancer survivors, we examined the sociodemographic characteristics, access to care factors, risk behavior factors, and chronic health conditions associated with screening utilization among breast, cervical, prostate, skin, and lung cancer survivors, using a nationally representative sample of US participants.

Methods

Study design and setting

We performed secondary data analysis using the 2020 Behavioral Risk Factor Surveillance System (BRFSS). The BRFSS is a large cross-sectional survey administered annually by the Centers for Disease Control and Prevention (CDC) to about 400,000 adults, across all 50 states, the District of Columbia, Guam, and Puerto Rico. The BRFSS is a telephone-based survey that utilizes a multistage cluster sampling technique to give US representative estimates. The data is self-reported and includes information on health-related risk behaviors, chronic health conditions, and use of preventive services from noninstitutionalized adults aged ≥ 18 years residing in the US. The respective health departments from each state grant Institutional Review Board (IRB) approval for the distribution and collection of data using the BRFSS, and verbal consent as directed by the CDC survey [25]. More details about the BRFSS are available at https://www.cdc.gov/brfss/. Data extracted for this study were publicly available and de-identified and thus considered exempt from IRB review.

Study participants

The 2020 BRFSS had 401,958 respondents aged ≥ 18 years. To obtain an eligible sample for our study, we excluded 392,172 respondents with no cancer history ($n = 379{,}245$), most recent cancer diagnosis of CRC ($n = 851$), other than breast, cervical, prostate, skin, and lung cancer history ($n = 5430$), male reported history of breast cancer ($n = 17$), and missing information on CRC screening utilization ($n = 6$). Adults less than 45 or greater than 75 years of age were also excluded based on the American Cancer Society (ACS) and the U.S. Preventive Services Task Force (USPSTF) recently updated guidelines ($n = 6629$) [15, 26]. Male breast cancer survivors were excluded from analysis due to low representative sample. As a result, 9780 respondents were eligible and included in this study to examine the relationship between guideline-concordant CRC screening utilization and sociodemographic characteristics, access to care, risk behavior factors, and chronic disease conditions in cancer survivors. The sample comprised 1886 breast cancer survivors, 410 cervical cancer survivors, 1076 prostate cancer survivors, 6161 skin cancer survivors (including melanoma), and 247 lung cancer survivors (Supplementary Fig. 1).

Measures

Guideline-concordant CRC screening utilization was our primary outcome of interest. According to ACS and USPSTF

recommendations, adults aged 45 years or older who are at average risk of CRC should start regular colonoscopy every 10 years, flexible sigmoidoscopy every 5 years, or FOBT every year [15, 25]. Thus, respondents with a guideline-concordant CRC screening were classified as those that (1) had a colonoscopy within 10 years, (2) sigmoidoscopy within 5 years, or (3) FOBT within a year. Respondents that reported a colonoscopy more than 10 years, sigmoidoscopy more than 5 years, FOBT more than a year, or never used any of these three CRC screening options were defined as having *no guideline-discordant* CRC screening.

Our main factors included age, and factors related to access to care, risk behavior factors, and chronic disease conditions. We classified age into three age groups, 45–59, 60–69, and 70–74 years. Access to care factors included insurance status (yes or no), having a health care provider (yes or no), and recency of routine checkup (within past year or 2 years or more). Risk behavior factors included smoking (yes or no), binge drinking (yes or no), and body mass index (BMI) (normal, overweight, and obese). Furthermore, binge drinking was defined as having 5 or more drinks for men or 4 or more drinks for women on an occasion during past 30 days [27–29]. Normal BMI was classified as underweight and normal (< 25 kg/m^2); overweight was classified as BMI between 25 and 30 kg/m^2; and obese was classified as BMI greater than or equal to 30 kg/m^2. We included chronic disease conditions previously studied as confounders such as diabetes, coronary heart disease (CHD) or myocardial infarction (MI), stroke, chronic obstructive pulmonary disease (COPD), emphysema or chronic bronchitis, arthritis, depressive disorder, or kidney diseases (not including kidney stones, bladder infection, or incontinence) [30]. Number of chronic diseases was calculated from abovementioned chronic diseases and categorized into a three-level variable including (1) zero, (2) one to two chronic diseases, and (3) three or more chronic diseases. Other covariates of interest were age at first cancer diagnosis (< 40, 41–59, 60–79), gender (male or female), race/ethnicity (non-Hispanic White, non-Hispanic Black, other non-Hispanic/Hispanic), education (high school graduate or lower educational attainment, some college, college graduate), marital status (married, others, never married), annual household income (less than $50,000 or $50,000 or more), and rural areas (yes or no) (Table 1).

Statistical analysis

Survey weights were used to account for the complex BRFSS survey design and to generate representative results. All estimates are presented as weighted estimates. Descriptive statistics were performed to summarize sociodemographic characteristics, access to care, risk behavior factors, and chronic disease conditions among five types of survivors (breast, cervical, prostate, skin, and lung cancers). Cross-tabulation of frequency and weighted percentages were conducted to describe the differences across the five types of cancer survivors, using weighted chi square test. Five weighted multivariable logistic regression models were applied to assess the association between guideline-concordant CRC screening utilization and access to care, risk behavior factors, and chronic disease conditions among breast, cervical, prostate, skin, and lung cancer survivors. Given breast, cervical, and prostate cancers are gender-specific cancers, guideline-concordant CRC screening rates of breast and cervical cancers were only for female and prostate cancer was only for male. Logistic regression models for those gender-specific cancers also excluded gender. Observations with missing data, don't know, or refused responses in the included variables are presented in Supplementary Table 1 and removed for the multivariable analyses. All five regression analyses were adjusted for sociodemographic characteristics (gender, race/ethnicity, education, marital status, income, and rural areas) and age at first cancer diagnosis. Results were reported as odds ratios (ORs) and the associated 95% confidence intervals (CIs) and *p*-values. Data analyses were conducted using SAS Version 9.4, SAS Institute Inc., Cary, North Carolina. All the *p*-values were based on two-sided probability tests. The level of statistical significance was set at 0.05.

Results

Study participant characteristics and CRC screening utilization

Among 9780 cancer survivors included in the analysis, the majority were aged 60–69 years, had first cancer at 41–59 years, were Non-Hispanic White, had some college or college graduate education, were married, had an annual household income of $50,000 USD or more, and reported living in non-rural areas (Table 1). Most cervical cancer survivors were younger (55.7% of those aged 45–59 years) and had their first cancer at age < 40 years (67.7%). Among lung cancer survivors, 63% had a high school or lower level of education attainment, and 44.7% had an annual household income less than $50,000 USD. When examining access to care factors, most cancer survivors had insurance, health care providers, and recency of routine checkup within the past year. Reported smoking and binge drinking behaviors, overweight or obese, and one or two chronic disease conditions were also associated with the uptake of CRC screening across the five types of cancer survivorship. Compared to CRC screening rates in breast, prostate, skin, and lung cancer survivors, cervical cancer survivors had a lower rate

Table 1 The sociodemographic characteristics, access to care, risk behavior factors, chronic health condition, and guideline-concordant CRC screening of cancer survivors (*n*=9,780)

	Breast Cancer (*n*=1,886) *n* (%) [a]	**Cervical Cancer** (*n*=410) *n* (%) [a]	**Prostate Cancer** (*n*=1,076) *n* (%) [a]	**Skin Cancer** (*n*=6,161) *n* (%) [a]	**Lung Cancer** (*n*=247) *n* (%) [a]
Gender					
Male	NA	NA	1,076(100%)	2,918(48.5%)	100(40.9%)
Female	1,886 (100%)	410 (100%)	NA	3,243(51.5%)	147(59.1%)
Age					
45−59	480(32.8%)	198(55.7%)	107(11.7%)	1,536(29.2%)	47(22.5%)
60−69	877(44.5%)	145(34.4%)	509(46.2%)	2,739(44.8%)	111(40.2%)
70−74	529(22.8%)	67(9.9%)	460(42.1%)	1,886(26.0%)	89(37.4%)
Age at first cancer diagnosis					
< 40	190(9.4%)	275(67.7%)	31(3.3%)	726(13.6%)	19(7.5%)
41−59	1,111(63.0%)	92(24.8%)	451(42.0%)	3,091(51.6%)	94(40.6%)
60−79	545 (24.3%)	27(4.2%)	581(54.1%)	2,097(31.0%)	121(45.1%)
Race/ethnicity					
Non-Hispanic White	1,446(75.5%)	306(77.2%)	844(70.3%)	5,874(95.6%)	191(80.5%)
Non-Hispanic Black	208(15.3%)	30(8.4%)	147(24.2%)	32(0.9%)	26(13.3%)
Other non-Hispanic/Hispanic [b]	232(9.2%)	74(14.3%)	85(5.5%)	255(3.5%)	30(6.2%)
Education					
High school or lower	446(31.6%)	171(45.0%)	274(32.0%)	1,329(28.1%)	115(63.0%)
Some college [c]	552(33.3%)	120(32.5%)	275(31.9%)	1,737(33.8%)	83(27.3%)
College graduate	884(34.8%)	117(21.6%)	525(36.1%)	3,090(38.1%)	49(9.7%)
Marital Status					
Married	1,026(59.8%)	196(58.0%)	783(75.7%)	4,168(71.7%)	111(41.0%)
Others [d]	674(30.9%)	169(32.8%)	196(17.1%)	1,458(20.8%)	114(48.3%)
Never married	177(8.5%)	42(7.5%)	94(7.1%)	516(7.1%)	21(9.7%)
Income					
Less than 50,000	698(36.9%)	215(46.3%)	326(30.1%)	1,746(28.0%)	130(44.7%)
50,000 or more	860(46.9%)	132(35.1%)	598(55.9%)	3,524(56.5%)	68(28.1%)
Rural areas					
No	1,610(92.1%)	351(91.6%)	938(92.6%)	5,379(91.4%)	212(91.9%)
Yes	250(7.8%)	56(8.4%)	132(7.4%)	758(8.6%)	33(8.1%)
Insurance status					
No	34(2.8%)	27(8.3%)	17(3.7%)	142(3.2%)	5(1.1%)
Yes	1,847(97.0%)	380(90.6%)	1,055(95.5%)	6,008(96.7%)	242(98.9%)
Health care provider					
No	81(3.7%)	49(11.0%)	45(2.9%)	397(5.8%)	13(8.0%)
Yes	1,800(95.8%)	360(88.9%)	1,027(96.8%)	5,757(94.0%)	234(92.0%)
Missing	5(0.5%)	1(0.03%)	4(0.3%)	7(0.2%)	0
Recency of routine checkup					
Within past year	1,703(88.9%)	347(86.1%)	978(91.9%)	5,340(87.4%)	224(95.1%)
2 years or more	170(10.7%)	60(13.6%)	94(7.3%)	790(12.0%)	19(4.1%)
Current Smoker					
No	1,709(90.3%)	306(67.5%)	960(87.4%)	5,506(88.0%)	175(66.7%)
Yes	172(9.4%)	102(29.2%)	105(11.8%)	624(11.5%)	70(32.8%)
Binge drink [e]					
No	98(7.0%)	35(9.1%)	114(12.6%)	567(10.7%)	18(7.5%)
Yes	1,757(91.7%)	370(90.2%)	942(85.2%)	5,483(87.1%)	221(91.3%)

Table 1 (continued)

	Breast Cancer (*n*=1,886) *n* (%) [a]	Cervical Cancer (*n*=410) *n* (%) [a]	Prostate Cancer (*n*=1,076) *n* (%) [a]	Skin Cancer (*n*=6,161) *n* (%) [a]	Lung Cancer (*n*=247) *n* (%) [a]
BMI [f]					
Normal	590(29.9%)	108(26.8%)	232(19.6%)	1,917(27.2%)	86(33.0%)
Overweight	558(27.3%)	113(27.3%)	440(42.4%)	2,201(34.8%)	75(31.5%)
Obese	589(34.8%)	164(40.3%)	387(36.5%)	1,744(32.1%)	75(32.1%)
Chronic disease condition					
0	610(31.8%)	81(18.5%)	380(36.4%)	2,167(32.5%)	35(13.8%)
1−2	1,047(55.2%)	216(51.8%)	562(50.4%)	3,265(55.7%)	138(56.9%)
3+	229(13.0%)	113(29.6%)	134(13.3%)	729(11.8%)	74(29.4%)
Guideline-concordant CRC screening					
No	374(18.1%)	141(35.0%)	130(12.0%)	1,275(21.9%)	55(19.9%)
Yes	1,512(81.9%)	269(65.0%)	946(88.0%)	4,886(78.1%)	192(80.1%)

Abbreviation: *NA*, non-applicable; *CRC*, colorectal cancer; *BMI*, body mass index

[a]Data shown as frequency and weighted percentages. There are missing values for age at first cancer diagnosis, education, marital status, income, rural areas, insurance status, health care provider, recency of routine checkup, current smoker, binge drink, and BMI (data not shown, Supplementary Table 1)

[b]Other non-Hispanic include Asian, American Indian/Alaskan Native, and others

[c]Some college or technical school

[d]Divorced, widowed, or separated

[e]During the past 30 days, having 5 or more drinks for men or 4 or more drinks for women

[f]Normal includes underweight and normal

of 65% (breast cancer: 81.9%, prostate cancer: 88%, skin cancer: 78.1%, and lung cancer: 80.1%) (p-value < 0.001) (Table 1).

Table 2 examines the association between guideline-concordant CRC screening utilization and sociodemographic characteristics of the five types of cancer survivors. Higher CRC screening utilization was observed in the 60–74 years age group for breast, cervical, skin, and lung cancer survivors (p-value < 0.001), among Non-Hispanic Black for cervical (86.1%) and lung cancer (94.7%) survivors, and among Non-Hispanic White for skin cancer survivors (78.7%). Cervical, skin, and lung cancer survivors who first had cancer diagnoses at 60–79 years also reported higher CRC screening rates. In addition to age and race/ethnicity, the relationships between education level and CRC screening utilization were observed among cervical and skin cancer survivors (p-value < 0.05). Married breast and skin cancer survivors also reported higher CRC screening uptake. Skin and lung cancer survivors that earned more than $50,000 in yearly income were more likely to have greater guideline-concordant CRC screening (p-value < 0.05). Finally, we also observed that rural residence was associated with higher guideline-concordant CRC screening uptake in lung cancer patients (p-value < 0.05).

When exploring access to care variables, risk behavior factors, and chronic disease conditions, we observed greater CRC screening utilization among all cancer survivors when they reported having a health care provider (p-value < 0.05), insurance, recency of routine checkup within the past year, no smoking behaviors, and chronic disease conditions. Comparing to non-binge drinkers, 67.5% of cervical cancer survivors who had binge drinking behaviors received a guideline-concordant CRC screening (p-value = 0.01); however, lower CRC screening use was observed among lung cancer survivors who did not have binge drinking behaviors (96.1%) (p-value = 0.004). Higher CRC screening utilization was also observed among overweight and obese respondents in prostate and lung cancers (p-value < 0.05) (Table 3).

Determinants of CRC screening utilization

We used logistic regression to examine the relationship between age, access to care, risk behavior factors, and chronic disease conditions with guideline-concordant CRC screening utilization adjusting for other sociodemographic characteristics and age at first cancer diagnosis (Table 4). Relative to adults aged 45–59 years, older age (≥ 60 years) was associated with higher odds of CRC screening uptake among breast, cervical, and skin cancer survivors (p-value < 0.05). Female lung cancer survivors were more likely to be screened for CRC compared to male lung cancer survivors (OR = 5.06; 95% CI, 2.05–12.47). Respondents that had their recency of routine checkup within the prior two years or more had reduced odds of having CRC screening among cervical (OR = 0.06; 95% CI, 0.02–0.22), prostate (OR = 0.26; 95% CI, 0.14–0.49), and skin cancer (OR = 0.50;

Table 2 Association of sociodemographic characteristics and guideline-concordant CRC screening utilization among cancer survivors[a]

	Breast Cancer		**Cervical Cancer**		**Prostate Cancer**		**Skin Cancer**		**Lung Cancer**	
	CRC screening *n*(%)[a]	*P*-value [e]	CRC screening *n*(%)[a]	*P*-value [e]	CRC screening *n*(%)[a]	*P*-value[e]	CRC screening *n*(%)[a]	*P*-value [e]	CRC screening *n*(%)[a]	*P*-value [e]
Gender								0.813		0.116
Male	NA	NA	NA	NA	946(88.0%)	NA	2,332(78.3%)		74(74.6%)	
Female	1,512(81.9%)		269(65.0%)		NA		2,554(77.9%)		118(83.9%)	
Age		<0.001		<0.001		0.404		<0.001		<0.001
45−59	344(76.0%)		104(53.3%)		93(92.1%)		1,019(64.0%)		30(64.5%)	
60−69	727(83.3%)		111(77.6%)		439(87.9%)		2,278(83.7%)		93(80.5%)	
70−74	441(87.7%)		54(87.6%)		414(86.9%)		1,589(84.3%)		69(89.1%)	
Age at first cancer diagnosis		0.150		0.005		0.549		<0.001		<0.001
< 40	141(78.8%)		169(63.7%)		25(83.4%)		505(69.5%)		15(87.7%)	
41−59	874(80.4%)		64(61.5%)		395(89.4%)		2,420(77.3%)		71(70.7%)	
60−79	463(85.2%)		23(94.6%)		516(87.2%)		1,770(83.7%)		97(88.8%)	
Race/ethnicity		0.067		0.013		0.481		0.023		<0.001
Non-Hispanic White	1,117(82.2%)		204(63.3%)		742(87.8%)		4,676(78.7%)		144(77.1%)	
Non-Hispanic Black	173(85.7%)		24(86.1%)		128(89.7%)		25(70.7%)		23(94.7%)	
Other non-Hispanic/ Hispanic [b]	168(73.2%)		41(62.2%)		76(82.2%)		185(64.9%)		25(87.8%)	
Education		0.918		0.046		0.345		<0.001		0.767
High school or lower	354(82.3%)		103(61.1%)		235(85.6%)		978(72.1%)		87(79.3%)	
Some college	429(81.1%)		90(73.9%)		240(88.3%)		1,378(80.0%)		66(82.3%)	
College graduate [c]	726(82.2%)		75(62.5%)		471(89.9%)		2,527(81.0%)		39(79.1%)	
Marital Status		0.019		0.307		0.448		0.035		0.116
Married	843(83.0%)		131(65.4%)		699(88.9%)		3,375(79.5%)		90(81.3%)	
Others [d]	537(82.5%)		115(69.1%)		170(85.6%)		1,114(74.8%)		85(78.0%)	
Never married	123(69.7%)		22(54.6%)		75(83.7%)		383(74.7%)		17(93.7%)	
Income		0.924		0.322		0.094		0.001		0.035
Less than 50,000	543(82.6%)		135(63.5%)		271(85.0%)		1,307(72.9%)		99(76.3%)	
50,000 or more	705(82.8%)		92(69.2%)		545(89.8%)		2,869(80.1%)		55(85.4%)	
Rural areas		0.803		0.135		0.351		0.201		0.018
Yes	197(82.8%)		28(52.6%)		108(85.0%)		577(74.8%)		25(90.4%)	
No	1,298(81.8%)		239(66.2%)		832(88.2%)		4,289(78.4%)		165(79.2%)	

Abbreviation: *NA*, non-applicable; *CRC*, colorectal cancer

[a]Data shown as frequency and weighted percentages

[b]Other non-Hispanic include Asian, American Indian/Alaskan Native, and others

[c]Some college or technical school

[d]Divorced, widowed, or separated

[e]Weighted chi-square test was used

Table 3 Association of access to care, risk behavior factors, chronic health condition and guideline-concordant CRC screening utilization among cancer survivors[a]

	Breast Cancer		**Cervical Cancer**		**Prostate Cancer**		**Skin Cancer**		**Lung Cancer**	
	CRC screening *n*(%)[1]	*P*-value[d]	CRC screening *n*(%)[1]	*P*-value[d]	CRC screening *n*(%)[1]	*P*-value[d]	CRC screening *n*(%)[1]	*P*-value[d]	CRC screening *n*(%)[1]	*P*-value[d]
Insurance status		0.013		0.003		0.392		<0.001		<0.001
Yes	1,485(82.6%)		255(67.3%)		927(88.0%)		4,796(79.1%)		191(80.9%)	
No	25(59.3%)		12(42.8%)		15(82.9%)		81(49.0%)		1(11.4%)	
Health care provider		0.001		0.002		0.001		<0.001		<0.001
Yes	1,460(82.8%)		247(67.6%)		911(88.7%)		4,671(79.7%)		181(78.5%)	
No	49(58.8%)		21(43.9%)		31(63.6%)		211(51.9%)		11(97.9%)	
Recency of routine checkup		0.003		<0.001		<0.001		<0.001		0.886
Within past year	1,395(83.4%)		248(71.2%)		867(89.2%)		4,368(80.6%)		178(80.4%)	
2 years or more	109(70.9%)		20(26.1%)		76(71.9%)		500(61.8%)		11(79.2%)	
Current Smoker		0.005		0.003		0.135		<0.001		0.001
Yes	121(71.4%)		58(54.8%)		84(82.0%)		433(66.1%)		50(66.5%)	
No	1,387(82.9%)		210(71.8%)		853(88.8%)		4,430(79.7%)		140(86.7%)	
Binge drink [b]		0.311		0.010		0.195		0.466		0.004
Yes	1,408(81.7%)		249(67.5%)		837(89.0%)		4,379(78.4%)		171(78.6%)	
No	82(86.0%)		18(41.4%)		94(82.8%)		425(76.3%)		15(96.1%)	
BMI [c]		0.068		0.174		0.041		0.368		<0.001
Normal	464(79.2%)		69(63.1%)		201(83.0%)		1,471(76.4%)		55(65.2%)	
Overweight	452(81.0%)		77(60.2%)		377(86.7%)		1,785(79.5%)		65(92.3%)	
Obese	478(85.8%)		108(70.8%)		353(91.8%)		1,400(78.7%)		62(82.5%)	
Chronic disease condition		<0.001		<0.001		0.131		<0.001		<0.001
0	458(74.8%)		44(49.4%)		335(88.0%)		1,635(72.9%)		29(90.7%)	
1−2	862(83.5%)		139(63.5%)		487(86.4%)		2,658(80.5%)		97(71.5%)	
3+	192(92.3%)		86(77.6%)		124(93.8%)		593(81.4%)		66(91.7%)	

Abbreviation: *CRC*, colorectal cancer; *BMI*, body mass index

[a]Data shown as frequency and weighted percentages

[b]During the past 30 days, having 5 or more drinks for men or 4 or more drinks for women

[c]Normal includes underweight and normal

[d]Weighted chi-square test was used

Table 4 Multivariable logistic regression to examine the association of access to care, risk behavior factors, and chronic health condition on guideline-concordant CRC screening utilization[a]

	Breast Cancer		Cervical Cancer		Prostate Cancer		Skin Cancer		Lung Cancer	
Guideline-concordant CRC screening	1,512(81.9%)		269(65.0%)		946(88.0%)		4,886(78.1%)		192(80.1%)	
	OR (95%CI)	**P-value**	**OR (95%CI)**	**P-value**	**OR (95%CI)**	**P-value**	**OR (95%CI)**	**P-value**	**OR (95%CI)**	**P-value**
Gender		NA		NA		NA		0.586		<0.001
Male	NA		NA		NA		Reference		Reference	
Female	NA		NA		NA		1.07 (0.84,1.35)		*5.06(2.05,12.47)*	
Age		0.010		<0.001		0.678		<0.001		0.141
45–59	Reference		Reference		Reference		Reference		Reference	
60–69	*1.99 (1.23,3.24)*		*5.87(2.87, 12.02)*		0.89 (0.29,2.72)		*2.65 (1.99,3.53)*		0.81 (0.31,2.16)	
70–74	*2.16 (1.19,3.92)*		*3.40 (1.06,10.92)*		0.70 (0.21,2.32)		*2.99 (2.05,4.35)*		2.03 (0.42,9.76)	
Race/ethnicity		0.666		0.301		0.304		0.285		0.233
Non-Hispanic White	Reference		Reference		Reference		Reference		Reference	
Non-Hispanic Black	1.19(0.55,2.59)		1.09(0.36,3.32)		1.70(0.71,4.02)		0.62(0.15,2.53)		2.48(0.83,7.40)	
Other non-Hispanic/Hispanic [b]	0.76(0.37,1.59)		2.00(0.83,4.82)		0.72(0.29,1.79)		0.68(0.40,1.15)		1.58(0.61,4.10)	
Insurance status		0.439		0.040		0.552		0.156		0.018
No	Reference		Reference		Reference		Reference		Reference	
Yes	1.68 (0.45,6.30)		*2.81 (1.05 ,7.50)*		1.38 (0.47,4.03)		1.64 (0.83,3.24)		*11.7 (1.56,87.71)*	
Health care provider		0.525		0.521		0.120		0.003		0.109
No	Reference		Reference		Reference		Reference		Reference	
Yes	1.37 (0.52,3.60)		0.70 (0.23,2.10)		1.94 (0.84,4.49)		*1.99 (1.27,3.10)*		0.16 (0.02,1.53)	
Recency of routine checkup		0.102		<0.001		<0.001		<0.001		0.752
Within past year	Reference		Reference		Reference		Reference		Reference	
2 years or more	0.63 (0.36,1.10)		*0.06 (0.02,0.22)*		*0.26 (0.14,0.49)*		*0.50 (0.36,0.70)*		0.80 (0.20,3.24)	
Current Smoker		0.001		0.716		0.072		0.041		0.506
No	Reference		Reference		Reference		Reference		Reference	
Yes	*0.36 (0.20,0.65)*		0.87 (0.42,1.83)		0.48 (0.22,1.07)		*0.69 (0.48,0.99)*		1.41 (0.50,3.92)	
Binge drink [d]		0.020		0.118		0.117		0.252		0.239
No	Reference		Reference		Reference		Reference		Reference	
Yes	*0.34 (0.14,0.84)*		2.81 (0.77,10.26)		1.88 (0.85,4.13)		0.81 (0.57,1.16)		0.27 (0.03,2.48)	
BMI		0.742		0.857		0.124		0.579		<0.001
Normal [e]	Reference		Reference		Reference		Reference		Reference	
Overweight	1.05(0.64,1.70)		1.16(0.53,2.51)		0.93 (0.51,1.70)		1.04 (0.79,1.37)		*6.82 (2.44,19.06)*	
Obese	1.21(0.74, 2.00)		1.23(0.57,2.67)		1.88 (0.87,4.08)		0.90 (0.67,1.19)		*4.99(2.25, 11.09)*	
Chronic disease condition		<0.001		0.282		0.047		0.051		<0.001
0	Reference		Reference		Reference		Reference		Reference	
1–2	*1.88 (1.22,2.89)*		1.30 (0.54,3.10)		0.89(0.50,1.56)		*1.36 (1.06,1.74)*		*0.16 (0.04,0.61)*	
3+	*5.53 (2.62,11.68)*		1.92 (0.76,4.84)		*4.66(1.22,17.82)*		1.33 (0.88,2.01)		2.13 (0.27,16.90)	

Abbreviation: *NA*, non-applicable, *CRC*, colorectal cancer; *BMI*, body mass index

Italicized text indicates statistically significant result

[a]All models are adjusted for age at first cancer diagnosis and sociodemographic characteristics (data not shown), including education, marital status, income, and rural areas. Weighted logistic regression was used

[b]Other non-Hispanic include Asian, American Indian/Alaskan Native, and others

[c]Some college or technical school

[d]During the past 30 days, having 5 or more drinks for men or 4 or more drinks for women

[e]Normal includes underweight and normal

95% CI, 0.36–0.70) survivors. Respondents with one or more chronic disease conditions were more likely to have guideline-concordant CRC screening among breast, prostate, and skin cancer survivors; however, lung cancer survivors with one or two chronic disease conditions exhibited lower odds of receiving CRC screening (OR = 0.16; 95% CI, 0.04–0.61) compared to respondents without any chronic diseases. Overweight and obese lung cancer survivors were also associated with greater CRC screening uptake (p-value < 0.001). Other observations showed that respondents with any insurance coverage had the higher odds of CRC screening utilization in cervical (OR = 2.81; 95% CI, 1.05–7.50) and lung (OR = 11.7; 95% CI, 1.56–87.71) cancers. CRC screening utilization was lower for breast (OR = 0.36; 95% CI, 0.02–0.65) and skin (OR = 0.69; 95% CI, 0.48–0.99) cancer survivors that reported currently smoking.

Discussion

Although receiving appropriate cancer screening for secondary cancers is recommended due to increased risk among cancer survivors [14], data on CRC screening utilization among different cancer survivor groups are lacking. To our knowledge, this study is the first to examine guideline-concordant CRC screening utilization and determine the key factors among breast, cervical, prostate, skin, and lung cancer survivors.

Overall, 81.9%, 65%, 88%, 78.1%, and 80.1% of breast, cervical, prostate, skin, and lung cancer survivors received guideline-concordant CRC screening, respectively (p-value < 0.001). These findings are consistent with prior BRFSS studies examining screening behaviors among cancer survivors that reported between 70.8% and 80.9% cancer survivors receive CRC screening [18, 24]. In a study using 2014 BRFSS, 80.9% of eligible cancer survivors in breast, cervical, colorectal, melanoma, prostate, and other cancers were guideline-concordant for CRC screening [24]. Using 2010 BRFSS data, a similar result was reported by Homan and colleagues that 75.4% of breast cancer survivors were more likely to be guideline-concordant for their colonoscopy screening compared to female survivors of other cancers (70.8%) [18]. Also, over half of breast cancer survivors received recommended screening for CRC (65%) [31]. However, our data reports higher level of CRC screening utilization in breast and prostate cancer survivors compared to 44.2% of breast and 54.1% of prostate cancer survivors who had a colonoscopy screening in a multi-specialty practice [22]. This difference may be attributed to study design and population sample. This multi-specialty practice study was based on data abstracted from electronic medical records from 12 locations in the state of Maryland with a potential for missed entries on CRC screening use. They also did not examine screening behaviors in cervical, skin, and lung cancer patients. Additionally, we observed that cervical cancer survivors had slightly lower screening use (65%) compared to other types of cancer survivorships. Compared to a prior study, using cancer registries, 78% of cervical cancer survivors received CRC screening [32]. Higher screening use from this study may be due to using registry-based data, which usually have more accurate information compared to self-reported data. Variations of CRC screening utilization across different cancer types may be influenced by doctor's recommendations on screening tests [23] and CRC risk perceptions [33, 34] as well as insurance coverage to access preventive care [32, 35]. Finally, more research on examining CRC screening behaviors in skin and lung cancer survivors are needed due to lack of existing literature.

An important insight from our study is that age continues to be an important factor in CRC screening. We observed that older breast, cervical, and skin cancer survivors were more likely to be guideline-concordant with CRC screening (p-value < 0.001). This finding is consistent with prior studies that reported older age was associated with a greater likelihood of receiving CRC screening among cancer survivors [22, 24]. In contrast to these findings, a state-based study reported increasing age was associated with a lower likelihood of receiving early detection screening for other cancers among women cancer survivors [31]. It is plausible that differences in their findings and ours are attributed to their study sample being younger with range 32–69 years compared to our sample range (45–74 years), and they also examined associations with other preventive care service use among cancer survivors [31].

Moreover, the role of chronic comorbidities was also highlighted in our results. We observed that survivors with multiple chronic diseases were more likely to receive guideline-concordant CRC screening compared to those without any chronic diseases. Particularly, breast and prostate cancer survivors that reported three or more chronic diseases were more than four times as likely to be screened for CRC. This finding is consistent with a study that indicated breast and prostate cancer survivors with hypertension were more likely to receive CRC screening compared to those without hypertension [22]. Our study also observed that lung cancer survivors living with obesity had a fourfold increased odds and participants with overweight BMI status had more than sixfold increased odds of guideline-concordant CRC compared with survivors with healthy weight or underweight BMI status. This is especially important given that research has consistently shown obesity is associated with an increased risk of colorectal cancer [36]. Higher CRC screening uptake may be due to increased doctor visits regarding cancer survivorship plans that could lead to adherence with other important preventive care, such as CRC screening [23, 24].

PCPs (i.e., obstetrics and gynecological doctors, family medicine doctors, and internal medicine physicians) appear to value survivorship care plans because they follow cancer patients during active treatment as well as after treatment completion [37]. Cancer survivors also prefer PCPs to lead their care for other preventive care and management of comorbid conditions [38]. In our study, we observed that cancer survivors with a recency of routine checkup at 2 years or greater have between 20 and 94% reduced likelihood of receipt of guideline-concordant CRC screening, a finding that may be linked to a lack of physician recommendation attributed to the absence of an ongoing PCP-patient relationship. Medical mistrust in healthcare providers experienced by patients or lack of patients' trust may be explained through mechanisms such as patient preference in gender, race, or identity concordance with their provider, or the patients' may have an expectation for specialist-led care, which in turn drive either stronger or reduced relationships with their PCPs [39–42]. In addition, limited time and workload pressure among providers may be the drivers for lack of communication between patient and provider [39]. Having insurance coverage to preventive health services for common cancer screening may also explain access to CRC screening [35, 43], which is consistent with our finding that having insurance was associated with CRC screening uptake. Therefore, patient-physician CRC screening communication could become a critical channel for timely CRC screening use among cancer survivors [44, 45].

Given an increased risk of a subsequent diagnosis of CRC among prostate cancer survivors [5], ongoing educational programs tailored to prostate cancer survivors are needed to increase CRC screening use. This is because we observed that those aged 60 years or older were less likely to receive timely screening compared to those aged less than 50 years, though not statistically significant. Another important finding is that lung cancer survivors with one or two chronic diseases were less likely to receive timely CRC screening. The presence of comorbid conditions was associated with poorer survival at different stages in lung cancer patients [46]; thus, this may lead physicians to be less likely to offer screening and for patients to be less likely to accept other preventive services [30, 47]. However, BRFSS is not a cancer surveillance database and does not collect information regarding cancer prognosis, progression, treatment, and therapy and thus we were unable to examine cancer staging in lung cancer survivors. Finally, our study observed that breast cancer survivors with current smoking and increased drinking behaviors were less likely to receive CRC screening. Educational programs to promote smoking and/or drinking cessation in this subgroup are needed, given cigarette smoking and drinking are major risk factors for CRC [48, 49]. Patient navigation to promote smoking cessation is also critical for skin cancer patients due to their lower likelihood of being for CRC screening in our analysis.

While professional organizations have issued screening recommendations for CRC, variations of CRC screening uptake still exist across varying cancer-specific survivors. Thus, professional organizations should strongly consider evidence on cancer-specific risks for secondary colorectal cancer development, and thus establish guidelines that may promote cancer survivors to increase adherence to CRC screening recommendations. Moreover, effective implementation of patient and provider communication regarding CRC screening recommendation in cancer survivorship care may also increase adherence to screening uptake across different cancer survivorships. In addition to reinforcing the important efforts to involve primary care in cancer survivorship plans, patient education programs are also needed to promote adherence to healthy lifestyle choices. Adherence to healthy lifestyle among cancer survivors, including tobacco reduction and cessation, limiting alcohol consumption, and maintaining a healthy weight, may reduce cancer recurrence and secondary cancer risk. Finally, our results may not apply to the impact of the SAR-COV-2 (COVID-19) pandemic on CRC screening utilization because the outbreak had just begun in 2020 and most participants either completed timely screening or are not yet due for another one. Given reversal of gains in CRC screening are significant after the onset of the COVID-19 pandemic [50], it is timely for further research to re-examine barriers to screening uptake.

Although strengths of this study included the three most common CRC screening tests and multiple factors across different cancer survivorships, this study has important limitations that should be noted. First, we performed a cross-sectional analysis, and therefore, a temporal relationship between sociodemographic characteristics, access to care, risk behavior factors, and chronic disease conditions with guideline-concordant CRC screening utilization could not be established. Second, the survey question design for cancer survivorship was to collect respondents' most recent cancer type. If participants had multiple cancers and the most recent one was not CRC, we were unable to exclude them from this study. CRC screening utilization may be underestimated for those with CRC history due to ongoing cancer treatment or follow-up care to detect recurrence. Third, over 90% of BRFSS sample was insured; thus, the CRC screening utilization may not be generalizable to those without insurance who may experience barriers in accessing preventive care. Moreover, as with any self-reported survey research, study participants may have given socially acceptable responses instead of answering with the accurate facts. Recall bias may also have affected the accuracy of responses. Therefore, guideline-concordant CRC screening utilization might be either overestimated or underestimated. Finally, we are unable to include time since cancer diagnosis as a covariate because BRFSS survey is not a cancer surveillance database and does not collect information regarding cancer prognosis and progression.

Conclusion

Findings from this study provide important information on factors that may be associated with national recommendations for CRC screening utilization within different cancer survivors. Our results suggest that older age, having recency of routine checkup within a year, and having chronic diseases were strongly associated with timely CRC screening uptake. Insurance, current smoking status, binge drink behaviors, and overweight/obese could also influence screening behaviors. Given the variations of CRC screening uptake across cancer survivors, these factors should be investigated further to optimize follow-up care in promoting secondary prevention of CRC through timely CRC screening. The importance of secondary cancer prevention in survivorship care plans for breast, cervical, prostate, skin, and lung cancer survivors, and effective implementation of such plans through primary health care initiatives are necessary.

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Author contribution All authors contributed to the study conception. Material preparation and data analysis were performed by Meng-Han Tsai and Justin X. Moore. The first draft of the manuscript was written by Meng-Han Tsai and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Data availability The datasets generated during the current study are available in the Center for Disease Control and Prevention repository, https://www.cdc.gov/brfss/.

Declarations

Ethics approval The respective health departments from each state grant Institutional Review Board (IRB) approval for the distribution and collection of data using the BRFSS. Data extracted for this study were publicly available and de-identified and thus considered exempt from IRB review at Augusta University. This article does not include any studies with animals performed by any of the authors.

Consent to participate Verbal informed consent was obtained from all individual participants included in the study as per the BRFSS process for data collection.

Consent for publication This study does not include any individual person's data in any form (including any individual details, images, or videos).

Conflict of interest The authors declare no competing interests.

References

1 Siegel RL, Miller KD, Fuchs HE, Jemal A. Cancer statistics, 2022. CA Cancer J Clin. 2022;72(1):7–33.
2 Brenner H, Chen C. The colorectal cancer epidemic: challenges and opportunities for primary, secondary and tertiary prevention. Br J Cancer. 2018;119(7):785–92.
3 Siegel RL, Miller KD, Fuchs HE, Jemal A. Cancer statistics, 2021. CA Cancer J Clin. 2021;71(1):7–33.
4 Secondary Primary Cancers. Available from: https://dceg.cancer.gov/research/what-we-study/second-cancers. Accessed May 31, 2022.
5 Desautels D, Czaykowski P, Nugent Z, Demers AA, Mahmud SM, Singh H. Risk of colorectal cancer after the diagnosis of prostate cancer: a population-based study. Cancer. 2016;122(8):1254–60.
6 Baxter NN, Tepper JE, Durham SB, Rothenberger DA, Virnig BA. Increased risk of rectal cancer after prostate radiation: a population-based study. Gastroenterology. 2005;128(4):819–24.
7 Davis EJ, Beebe-Dimmer JL, Yee CL, Cooney KA. Risk of second primary tumors in men diagnosed with prostate cancer: a population-based cohort study. Cancer. 2014;120(17):2735–41.
8 Travis LB. Controversies: therapy-associated solid tumors. Acta Oncol. 2002;41:323–33.
9 Travis LB, Rabkin C, Brown LM, Allan JM, Alter BP, Ambrosone CB, et al. Cancer survivorship—genetic susceptibility and second primary cancers: research strategies and recommendations. J Natl Cancer Inst. 2006;98:15–25.
10 Molina-Montes E, Requena M, Sánchez-Cantalejo E, Fernández MF, Arroyo-Morales M, Espín J, Arrebola JP, et al. Risk of second cancers cancer after a first primary breast cancer: a systematic review and meta-analysis. Gynecol Oncol. 2015;136(1):158–71.
11 American Cancer Society, After cervical cancer treatment. Available from: https://www.cancer.org/content/dam/CRC/PDF/Public/8603.00.pdf. Accessed 3 May 2022.
12 Kato T, Suzuki K, Muto Y, Sasaki J, Tsujinaka S, Kawamura YJ, et al. Multiple primary malignancies involving primary sporadic colorectal cancer in Japan: incidence of gastric cancer with colorectal cancer patients may be higher than previously recognized. World J Surg Oncol. 2015;13:23.
13 Samo S, Sherid M, Husein H, Sulaiman S, Vainder JA. Metastatic malignant melanoma to the colon: a case report and review of the literature. J Gastrointest Cancer. 2014;45(2):221–4.
14 Mariotto AB, Ries L, Scoppa S, Feuer E. Multiple cancer prevalence: a growing challenge in long-term survivorship. Cancer Epidemiol Biomarkers Prev. 2007;16(3):566–71.
15 US Preventive Services Task Force, Davidson KW, Barry MJ, Mangione CM, Cabana M, Caughey AB, et al. Screening for colorectal cancer: US Preventive Services Task Force Recommendation Statement. JAMA. 2021;325(19):1965–77.
16 American Cancer Society Guideline for Colorectal Cancer Screening. Available from: https://www.cancer.org/cancer/colon-rectal-cancer/detection-diagnosis-staging/acs-recommendations.html#written_by9. Accessed 31 May 2022.
17 Richardson LC, King JB, Thomas CC, Richards TB, Dowling NF, Coleman King S. Adults Who have never been screened for colorectal cancer, behavioral risk factor surveillance system, 2012 and 2020. Prev Chronic Dis. 2022;19:220001.
18 Homan SG, Kayani N, Risk YS. Risk factors, preventive practices, and health care among breast cancer survivors, United States, 2010. Prev Chronic Dis. 2016;13:E09.

19 Mandelzweig L, Chetrit A, Amitai T, Silverman B, Siegelmann-Danieli N, Sadetzki S. Primary prevention and screening practices among long-term breast cancer survivors. Cancer Causes Control. 2017;28(7):657–66.

20 Breslau ES, Jeffery DD, Davis WW, Moser RP, McNeel TS, Hawley S. Cancer screening practices among racially and ethnically diverse breast cancer survivors: results from the 2001 and 2003 California health interview survey. J Cancer Surviv. 2010;4(1):1–14.

21 Salz T, Weinberger M, Ayanian JZ, Brewer NT, Earle CC, Elston Lafata J, et al. Variation in use of surveillance colonoscopy among colorectal cancer survivors in the United States. BMC Health Serv Res. 2010;10:256.

22 Dash C, Lu J, Parikh V, Wathen S, Shah S, Shah Chaudhari R, et al. Disparities in colorectal cancer screening among breast and prostate cancer survivors. Cancer Med. 2021;10(4):1448–56.

23 Huang Y, Soon YY, Ngo LP, Dina Ee YH, Tai BC, Wong HC, et al. A cross-sectional study of knowledge, attitude, and barriers to colorectal cancer screening among cancer survivors. Asian Pac J Cancer Prev. 2019;20(6):1817–24.

24 Shay LA, Schmidt S, Dioun SI, Grimes A, Embry L. Receipt of a survivorship care plan and self-reported health behaviors among cancer survivors. J Cancer Surviv. 2019;13(2):180–6.

25 Centers for Disease Control and Prevention (CDC). Behavioral risk factor surveillance system survey data. Atlanta, Georgia: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention; 2020.

26 Wolf AMD, Fontham ETH, Church TR, Flowers CR, Guerra CE, LaMonte SJ, et al. Colorectal cancer screening for average-risk adults: 2018 guideline update from the American Cancer Society. CA Cancer J Clin. 2018;68(4):250–81.

27 Esser MB, Hedden SL, Kanny D, Brewer RD, Gfroerer JC, Naimi TS. Prevalence of alcohol dependence among US adult drinkers, 2009–2011. Prev Chronic Dis. 2014;11:140329.

28 Sacks JJ, Gonzales KR, Bouchery EE, Tomedi LE, Brewer RD. 2010 national and state costs of excessive alcohol consumption. Am J Prev Med. 2015;49(5):e73–9.

29 Stahre M, Roeber J, Kanny D, Brewer RD, Zhang X. Contribution of excessive alcohol consumption to deaths and years of potential life lost in the United States. Prev Chronic Dis. 2014;11:130293.

30 Greiner B, Gandhi R, Abrol R, Patel M, Hartwell M. National disparities in colorectal cancer screening in patients with comorbid conditions: an analysis of the Behavioral Risk Factor Surveillance System. J Osteopath Med. 2021;121(7):657–62.

31 Glenn BA, Nonzee NJ, Hamilton AS, Tieu L, Maxwell AE, Crespi CM, et al. Cancer surveillance and preventive services in a diverse sample of breast and colorectal cancer survivors. J Cancer Surviv. 2021;15(2):213–23.

32 Senkomago V, Greek A, Jackson JE, Thomas CC, Richardson LC, Benard VB. Learning from cervical cancer survivors: an examination of barriers and facilitators to cervical cancer screening among women in the United States. J Prim Care Community Health. 2021;12:21501327211041864.

33 Tsai MH, Cabral DN, Gishe J, Dagne GA. Colorectal cancer risk perceptions in Black Men, submitted to 2022 Society for Epidemiologic Research Annual Meeting, Jun 14–17, 2022. Poster session.

34 Taha H, Jaghbeer MA, Al-Sabbagh MQ, Al Omari L, Berggren V. Knowledge and practices of colorectal cancer early detection examinations in Jordan: a cross sectional study. Asian Pac J Cancer Prev. 2019;20(3):831–8.

35 MacDonald M, Mirza AS, Mhaskar R, Ewing A, Chen L, Robinson K, et al. Preventative cancer screening rates among uninsured patients in free clinics: a retrospective cohort study of cancer survivors and non-cancer survivors. Cancer Control. 2022;29:10732748211072984.

36 Bardou M, Barkun AN, Martel M. Obesity and colorectal cancer. Gut. 2013;62(6):933–47.

37 Sussman J, Bainbridge D, Evans WK. Towards integrating primary care with cancer care: a regional study of current gaps and opportunities in Canada. Healthc Policy. 2017;12:50–65.

38 Smith TG, Strollo S, Hu X, Earle CC, Leach CR, Nekhlyudov L. Understanding long-term cancer survivors' preferences for ongoing medical care. J Gen Intern Med. 2019;34(10):2091–7.

39 Lawrence RA, McLoone JK, Wakefield CE, Cohn RJ. Primary care physicians' perspectives of their role in cancer care: a systematic review. J Gen Intern Med. 2016;31(10):1222–36.

40 Sutton AL, He J, Edmonds MC, Sheppard VB. Medical mistrust in Black breast cancer patients: acknowledging the roles of the trustor and the trustee. J Cancer Educ. 2019;34(3):600–7.

41 Adams LB, Richmond J, Corbie-Smith G, Powell W. Medical mistrust and colorectal cancer screening among African Americans. J Community Health. 2017;42(5):1044–61.

42 Haviland K, Burrows Walters C, Newman S. Barriers to palliative care in sexual and gender minority patients with cancer: a scoping review of the literature. Health Soc Care Community. 2021;29(2):305–18.

43 Gupta S, Cole AP, Marchese M, Wang Y, Speed JM, Fletcher SA, et al. Use of preventive health services among cancer survivors in the US. Am J Prev Med. 2018;55(6):830–8.

44 Maxwell AE, Lucas-Wright A, Chang LC, Santifer RE, Crespi CM. Factors associated with colorectal cancer screening in a peer-counseling intervention study in partnership with African American churches. Prev Med Rep. 2020;20:101280.

45 Lafata JE, Cooper G, Divine G, Oja-Tebbe N, Flocke SA. Patient-physician colorectal cancer screening discussion content and patients' use of colorectal cancer screening. Patient Educ Couns. 2014;94(1):76–82.

46 Islam KM, Jiang X, Anggondowati T, Lin G, Ganti AK. Comorbidity and survival in lung cancer patients. Cancer Epidemiol Biomarkers Prev. 2015;24(7):1079–85.

47 Maratt JK, Calderwood AH. Colorectal cancer screening and surveillance colonoscopy in older adults. Curr Treat Options Gastroenterol. 2019;17(2):292–302.

48 Bai X, Wei H, Liu W, Coker OO, Gou H, Liu C, et al. Cigarette smoke promotes colorectal cancer through modulation of gut microbiota and related metabolites. Gut. 2022:gutjnl-2021–325021.

49. Rossi M, Jahanzaib Anwar M, Usman A, Keshavarzian A, Bishehsari F. Colorectal cancer and alcohol consumption-populations to molecules. Cancers (Basel). 2018;10(2):38.

50 Mazidimoradi A, Tiznobaik A, Salehiniya H. Impact of the COVID-19 pandemic on colorectal cancer screening: a systematic review. J Gastrointest Cancer. 2021;1–15.