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Assessment of colorectal cancer screening in rural Appalachian Ohio and Kentucky: Results from a random-digit-dialed telephone survey

Mark Dignan[2*], Electra D. Paskett[4,5,6], Jill M. Oliveri[4], Robin C. Vanderpool[3#], Mira L. Katz[4,5], Paul L. Reiter[5], Darrell M. Gray II[4,6], Michael L. Pennell[5], Gregory S. Young[6], Julie A Stephens[7], Bin Huang[3], Darla Fickle[4], Aaron J. Kruse-Diehr[2,3], Mark Cromo[3], Angela Carman[1], Melinda Rogers[3], David Gross[8], Vickie Fairchild[8], Roshmita Bardhan[9] and Margaret Geertz[9]

[1]College of Public Health, University of Kentucky, USA

[2]College of Medicine, University of Kentucky, USA

[3]Markey Cancer Center, University of Kentucky, USA

[4]The Ohio State University Comprehensive Cancer Center, USA

[5]College of Public Health, The Ohio State University, Columbus, USA

[6]College of Medicine, The Ohio State University, USA

[7]Center for Biostatistics, Department of Biomedical Informatics, College of Medicine, The Ohio State University, USA

[8]Northeast Kentucky Area Health Education Center, USA

[9]Kentucky College of Osteopathic Medicine, USA

[#]Robin Vanderpool, Dr, PhD was formerly with the University of Kentucky Markey Cancer Center and was a co- investigator on the ACCSIS Appalachia grant during year 1. She is now employed by the National Cancer Institute. The opinions expressed by the authors are their own and this material should not be interpreted as representing the official viewpoint of the U.S. Department of Health and Human Services, the National Institutes of Health or the National Cancer Institute.

Abstract

The Appalachian region of the US is a 205,000 square mile region comprised of 420 counties in 13 states positioned along the spine of the Appalachian Mountains stretching from New York to Mississippi. The Appalachian region has higher than average colorectal cancer (CRC) incidence and mortality rates with Kentucky and Ohio having some of the highest rates in the nation. Rates for screening colonoscopy, sigmoidoscopy and stool blood tests (fecal occult, fecal immunochemical) and stool DNA testing rates are lower in Appalachian regions of Kentucky and Ohio as compared to the non-Appalachian regions and are associated with intrapersonal, health care provider, and state and community barriers such as limited access to health care and poverty. 'Accelerating Colorectal Cancer Screening through Implementation Science in Appalachia (ACCSIS Appalachia)' is funded by the NCI Cancer Moonshot℠ initiative and is designed to test implementation of multi-level interventions to increase CRC screening and follow-up. One of the measures of effectiveness of ACCSIS Appalachia is CRC screening rates in the study population, which includes 12 counties in Appalachian Ohio and Kentucky. Screening rates in study counties were collected through a series of random digit dialed telephone surveys of the study area population. In this report, we describe the survey methodology and present data from the initial survey carried out to establish baseline data.

Background

Appalachia is a 13-state region that follows the Appalachian mountain range from the southernmost counties in New York to northeastern Mississippi [1]. The Appalachian population exceeds 25 million, with almost half classified as rural, and a majority of the residents are White and non-Hispanic [2]. Residents of Appalachia are more likely to have lower incomes, lower levels of education, higher poverty and unemployment rates, and poorer health than their non-Appalachian counterparts [3].

The Appalachian region has higher than average incidence [4] and mortality rates for colorectal cancer (CRC), with Kentucky and Ohio experiencing some of the highest rates in the nation [5]. Although screening tests for CRC are available, rates for screening colonoscopy, sigmoidoscopy and stool blood tests (fecal occult, fecal immunochemical) and stool DNA testing rates are lower in Appalachian regions of Kentucky and Ohio than the non-Appalachian regions of the states [6]. Low CRC screening rates in Appalachia are not only associated with intrapersonal and health care provider-related factors but are also linked to state and community factors such as access to health care and poverty [7-9]. Though providers and health care delivery systems have clear roles in recommending and providing access to CRC screening, increased screening rates are also reliant on community and patient factors such as knowledge and fears associated

Correspondence to: Mark Dignan, PhD, University of Kentucky, College of Medicine, Department of Internal Medicine, 760 Press Avenue, Room 335, Lexington, KY 40536-0679, USA, E-mail: Mark.dignan@uky.edu

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with screening specifically, and cancer in general [10,11]. Researchers at the University of Kentucky (UK) and Ohio State University (OSU) have conducted research on CRC in Appalachia and identified factors that influence screening at multiple levels including patient, community, health care system and provider levels [12]. Building on this experience, as part of 'Accelerating Colorectal Cancer Screening through Implementation Science in Appalachia (ACCSIS) - a project funded by the NCI Cancer Moonshot℠ initiative, the investigators are conducting research that implements multilevel interventions to simultaneously address multiple levels of influence – clinic, provider, patient and community -- rather than address individual levels one at a time. One of the measures of effectiveness of ACCSIS is estimates of county level rates of CRC screening in the study population collected through a series of telephone surveys of the study area population. In this report, we describe the survey methodology and present data from the initial survey carried out to establish baseline telephone survey data for the project.

Methods

A detailed description of ACCSIS development has been presented in a previous publication [13]. Six counties in Ohio and 6 counties in Kentucky were selected for the study (Figure 1) While the US age-adjusted CRC mortality rate for 2010-2014 was 48.9 per 100,000 when ACCSIS was initiated, the statewide rates for Kentucky and Ohio were 57.3 and 54.3, respectively, and the rates for these 12 ACCSIS study counties were substantially higher than the state rates, ranging from 61.2 to 111.9 per 100,000 [14]. These counties were selected due to their high CRC mortality rates, in addition to low socioeconomic status. Within each of the selected counties primary health care services were recruited. Primary healthcare partners were selected in each county and included a mixture of federally qualified health centers (FQHC), satellite primary care clinics of regional hospitals, and one public health department primary care clinic.

Study design

The 12 counties were paired and randomized to early and delayed intervention arms within each state. The intervention was to be implemented at the clinics within the counties, with usual care continuing until the start of the intervention in the early and delayed intervention arms, respectively. Data for a key outcome of the study, the population estimate of the rate of CRC screenings at the county level, was assessed using results from telephone surveys carried out with a random sample of adult residents aged 50-74. The survey data allows assessment of change in the rate of CRC screening at the county level over the course of the project. The 30- item surveys were designed to be approximately 10 minutes in length and to emulate the standard Behavioral Risk Factor Surveillance System (BRFSS) surveys [15]. Questions included socio-demographic characteristics (e.g., sex, age, ethnicity/race, education, income, employment); access to health care; CRC screening (e.g., stool blood testing, colonoscopy and sigmoidoscopy, frequency since last CRC test); and barriers to CRC screening. Open-ended responses were collected for items inquiring about reasons for not having CRC screening. The survey was designed to be anonymous, with zip code as the only personal health information collected. Interviewers contacted potential participants, determined eligibility, and administered verbal consent followed by the survey items.

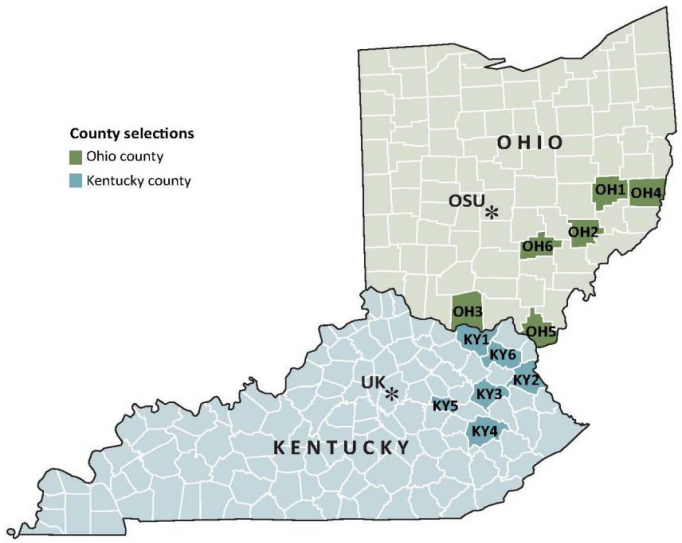

Figure 1. ACCSIS Appalachia Study Counties

The telephone survey was designed to include data collection from 100 respondents in each of the 12 study counties. The sample size calculation was based on an analysis of covariance (ANCOVA) model comparing the change in CRC screening rate between the early and delayed intervention groups controlling for the baseline screening rate in each county. Using data from our formative evaluation that showed the average screening rate in the study population to be approximately 62% among residents age 50-74, 100 surveys would provide 92% power to detect an increase in CRC screening rate from 62% to 75% after 12 months of intervention, assuming no change in screening rate among control counties over the same time period, an intraclass correlation coefficient of 0.012, and a moderate correlation between the pre- and post- treatment screening rates (r=0.5).

Survey implementation

Telephone surveys were conducted under contract with a survey research center with experience administering the BRFSS. The telephone surveys employed a dual frame (landline and cell phone) sampling procedure. Telephone numbers were randomly selected from two databases provided by the Marketing Systems Group, the 'Listed Household' and 'Consumer Cell' databases. These databases contain demographic information on households and allow identification of households in the 12-county study area that have at least one resident aged 50-74. The contractor had extensive experience in survey administration that meets high technical (i.e., CATI program requirements) and professional standards. The staff had conducted interviews with a wide variety of subject populations, and topics of interviews ranged from the ordinary to extremely sensitive personal questions regarding attitudes about race relations, sexual practices, domestic violence, suicide ideation, and drug abuse. All interviewers completed several hours of basic interviewer training, were certified in Human Subjects Protection, and received extensive study-specific training.

Statistical analysis

Demographic characteristics of the responders were summarized using frequencies and percentages. Survey results were weighted to account for the stratified sampling design and differences in the age/sex distribution between the sample and the population in each county. Weighted survey responses, stratified by county, for self-reported health care access, CRC screening, and cancer risk were

calculated overall and by state. Logistic regression was used to estimate unadjusted associations between demographic/clinical factors and within guidelines CRC screening status [16,17] accounting for the survey weights. Factors significant at the 0.2 level were included in a backwards selection algorithm to identify factors significantly ($p<0.05$) associated with being within guidelines for CRC screening after adjusting for other explanatory variables. All analyses were performed using SAS Version 9.4 (SAS Inc, Cary, NC). All statistical tests were two sided with a 0.05 level of significance.

Results

The surveys were implemented in each of the 12 study counties between April and September 2019. Up to 15 attempts were made to each landline number in the samples and up to 8 attempts to each cell phone number in the samples. In addition, up to 10 scheduled call-backs were made to those reached at an inconvenient time, and one refusal conversion was attempted for soft refusals. For Kentucky a total of 2438 calls were completed with 1337 (54.8%) refusals, 484 (19.9%) determined to be not eligible, and 617 (25.3%) interviews completed. In Ohio, 4083 calls were completed with 2917 (71.4%) refusals, 562 (13.7%) not eligible, and 604 (20.7%) interviews completed. Demographic characteristics of the interview respondents are shown in Table 1. The mean age of all 1221 respondents was 63.2 years (sd=6.7), with mean ages for the respondents in KY and respondents in OH 63.21 and 63.22 years, respectively. The respondents were predominately non-Hispanic white (99.6%), and most (66%) reported being currently married or living with a partner. Over 40% had less than high school/GED education, over 60% reported being retired or unable to work, and nearly two-thirds (65.6%) reported an annual income of less than $50,000/year. About 20% of the respondents reported a history of a cancer diagnosis, with breast and melanoma being the most common cancer types. While approximately 20% reported ever having cancer, only 14 respondents (4.9%) reported a diagnosis of CRC; 5 (4.0%) in OH and 9 (5.8%) in KY. Of the 14 respondents with a history of CRC, the average age at diagnosis was 51.1 years.

Survey responses reporting on health care access, CRC screening history, smoking, previous cancer diagnoses and risk factors are shown in Table 2. A majority of the respondents reported having access to a health care provider and having had a regular check-up within the past year. About one third reported ever having had a stool blood test, and a greater proportion reported a previous colonoscopy or sigmoidoscopy.

About half of the survey respondents who reported a previous abnormal colonoscopy also reported having polyps removed.

Participants reporting never having CRC screening were also asked in an open-ended format to provide a reason or reasons why they had not been screened. The open-ended responses were reviewed and coded into the categories shown in Table 3. Personal factors such as knowledge, opinions and fears associated with CRC and screening were the most frequent reasons provided, followed by barriers such as transportation and out-of-pocket cost. Lack of provider recommendation was also reported (9.8%) as a factor underlying never having CRC screening.

Adherence with CRC screening guidelines

Overall, 74.6% (weighted) of the participants reported CRC screening within recommended screening guidelines [14]. The percent within guidelines was similar in OH and KY (74.3% and 74.9%, respectively). However, the 2018 BRFSS survey reported somewhat lower adherence rates with 67.2% and 69.6% having fully met US Preventive Services Task Force (USPSTF) CRC screening recommendations in Ohio and Kentucky, respectively.

As seen in Table 4, being older, female, or married, or having health insurance, a provider, a check-up within the last year, or a cancer diagnosis were all associated with increased odds of adherence with CRC screening as recommended by the USPSTF. With the exception of health insurance, each of these factors was also significant in our multivariable logistic regression model (Table 5).

Discussion

In a cross-sectional survey among residents of Appalachia Ohio and Kentucky where CRC mortality rates are among the highest in the US, self-reported rates of being within guidelines for CRC screening were higher than statewide BRFSS rates. In addition, factors identified in previous studies assessing CRC adherence to guideline recommendation as associated with being up-to-date with screening were also found in this analysis – older age, having a health care provider and recent primary care visit; however, this study, unlike most previous studies, found that women were more likely to be up-to-date with CRC screening compared to men and those with a history of cancer were also more likely to be up-to-date compared to those without a history of cancer [15,16].

It is notable that the responses from the Ohio and Kentucky counties are similar for most survey items shown in Table 1. However, the similarity is not surprising given the homogeneity of the population in terms of elevated unemployment rates, low education attainment and low income. Reflective of the population, the survey respondents were primarily non-Hispanic white with reported annual household incomes under $50,000, and a plurality with a high school (or equivalent) education or less overall. The reported screening behaviors were also consistent with previous research with lower educational attainment and annual household income both associated with less adherence to screening guidelines [17,18]. However, where previous research has demonstrated that increasing age and having a regular source of care are both strongly associated with screening compliance [19], respondents in this survey skewed older (mean age=63.2 years) and with a relatively high proportion reporting having a healthcare provider (91.3%), it is possible that these factors partly explain the reported higher screening adherence (78%) than the overall rates of both Kentucky (69.6%, 2018) and Ohio (67.2%). It is also possible that nonresponse bias might partly explain this difference, given the large number of individuals who refused the survey (54.8% in KY, 71.4% in Ohio). Other survey research in Appalachian Kentucky has also noted higher reported screening compliance than state-wide rates [20].

Despite an overall high percentage of individuals adherent to screening guidelines in this survey, there was notable variation in adherence for those who used stool-based screening. Nearly 1/3 of respondents reported ever having a stool-based test, and of those individuals, 35.8% reported having a stool-based test in the last year. Yet nearly one-quarter (23.7%) reported that it had been over 5 years since their last FIT/FOBT/FIT- DNA. Only 5.4% of the individuals who had completed a stool-based test had positive results, and while some respondents may have chosen colonoscopy as a screening modality in years subsequent to having completed a stool-based test, it is likely that at least some of the individuals who reported having ever had a stool-based test are now out of screening adherence, given the necessity of re-screen after 1 or 3 years (FIT, FIT-DNA, respectively). Multiple studies have observed declining repeat stool-based screening among patients in subsequent years, and our study's findings underscore the

Table 1. Demographic Characteristics of Participants Overall and by State*

Variable	Level	Total n (%)	Ohio n (%)	Kentucky n (%)
Age	50-54	150 (12.3)	69 (11.4)	81 (13.1)
	55-59	229 (18.8)	113 (18.7)	116 (18.8)
	60-64	277 (22.7)	143 (23.7)	134 (21.7)
	65-69	292 (23.9)	155 (25.7)	137 (22.2)
	70-74	273 (22.4)	124 (20.5)	149 (24.1)
Sex at birth	Male	419 (34.3)	220 (36.4)	199 (32.3)
	Female	801 (65.6)	383 (63.4)	418 (67.8)
Race:	American Indian/Alaska Native	13 (1.1)	9 (2.0)	4 (0.7)
	Asian	1 (0.1)	0	1 (0.2)
	African-American	6 (0.5)	5 (0.8)	1 (0.2)
	Hispanic	6 (0.5)	3 (0.5)	3 (0.5)
	White, non-Hispanic	1158 (94.8)	571 (94.5)	587 (95.1)
	Multiple Races	26 (2.1)	9 (1.5)	17 (2.8)
	All other, non-Hispanic	7 (0.6)	4 (0.7)	3 (0.6)
Marital status	Married/living w partner	820 (67.2)	414 (68.5)	406 (65.8)
	Divorced/separated/widowed	325 (26.9)	151 (25.0)	174 (28.2)
	Never been married	72 (6.0)	35 (5.8)	37 (6.0)
Education	≤High School/GED	536 (44.0)	265 (43.9)	271 (44.1)
	Some college or associate degree	335 (27.5)	174 (28.9)	161 (26.2)
	Bachelor degree or more	347 (28.5)	165 (27.2)	182 (29.6)
	Missing	3 (0.3)	0 (0.0)	3 (0.5)
Employment	Employed for wages	266 (21.9)	158 (26.2)	108 (17.6)
	Self-employed	83 (6.8)	41 (6.8)	42 (6.9)
	Unemployed	15 (1.2)	10 (1.7)	5 (0.8)
	Homemaker or student	87 (7.2)	46 (7.6)	41 (6.7)
	Retired	572 (47.2)	274 (45.4)	298 (48.6)
	Unable to work	190 (15.6)	72 (11.9)	118 (19.1)
Health Insurance	Uninsured	41 (3.4)	25 (5.8)	16 (2.6)
	Public; Medicaid, Medicare, Military	658 (54.6)	149 (34.5)	347 (56.7)
	Private	435 (36.1)	232 (53.7)	203 (33.2)
	Other	72 (6.0)	26 (6.0)	46 (7.5)
Household income	Less than $10,000	55 (4.5)	21 (3.5)	34 (5.5)
	$10,000 to 14,999	63 (5.2)	23 (3.8)	40 (6.5)
	$15,000 to 19,999	81 (6.6)	33 (5.5)	48 (7.8)
	$20,000 to 24,999	75 (6.1)	31 (5.1)	44 (7.1)
	$25,000 to 34,999	99 (8.11)	53 (8.8)	46 (7.5)
	$35,000 to 49,999	160 (13.1)	88 (14.6)	72 (11.7)
	$50,000 to 74,999	161 (13.2)	78 (12.9)	83 (13.5)
	$75,000 or more	231 (18.9)	133 (22.0)	98 (15.9)
	Refused/Don't Know	152 (24.6)	144 (23.8)	296 (24.2)
Smoke cigarettes every day, some days or not at all	Never Smoked	608 (49.8)	312 (51.7)	296 (48.0)
	Previous Smoker	383 (31.4)	182 (31.1)	201 (32.6)
	Currently Smoke Some days	54 (4.4)	24 (4.0)	30 (4.8)
	Currently Smoke Every day	176 (14.4)	86 (14.2)	90 (14.6)
Ever been told you have cancer	No	958 (78.5)	480 (79.5)	478 (77.5)
	Yes	263 (21.5)	124 (20.5)	139 (22.5)
	Bladder	1 (0.4)	0 (0.0)	1 (0.7)
	Brain	6 (2.3)	3 (2.4)	3 (2.2)
	Breast	54 (20.5)	26 (21.0)	28 (20.1)
	Cervical	18 (6.8)	12 (9.7)	6 (4.3)
	Colon	13 (4.9)	5 (4.0)	8 (5.8)
	Kidney	7 (2.7)	3 (2.4)	4 (2.9)
	Leukemia	6 (2.3)	4 (3.2)	2 (1.4)
	Liver	2 (0.8)	2 (1.6)	0 (0.0)
	Lung	10 (3.8)	3 (2.4)	7 (5.0)
	Lymphoma	5 (1.9)	2 (1.6)	3 (2.2)
	Melanoma-Skin	61 (23.2)	33 (26.6)	28 (20.1)
	Ovarian	11 (4.2)	1 (0.8)	10 (7.2)
	Prostate	10 (3.8)	7 (5.6)	3 (2.2)
	Stomach	4 (1.5)	0 (0.0)	4 (2.9)
	Uterus-Endometrial	12 (4.6)	6 (4.8)	6 (4.3)
	Other	40 (15.2)	16 (12.9)	24 (17.3)

*Note: Percentages may not total 100 due to missing data

Table 2. Self-Reported Health Care Access, Colorectal Cancer Screening and Cancer Risk by Study Area*

Variable	Levels	Ohio counties		Kentucky counties		Total	
		Unweighted Frequency (%)	Weighted (%)	Unweighted Frequency (%)	Weighted (%)	Weighted Frequency (%)	Weighted (%)
Access to health care provider	No	42 (6.8)	9.7	33 (5.4)	6.4	74 (6.1)	8.5
	Yes	562 (93.1)	90.3	584 (94.7)	93.6	1,146 (93.9)	91.3
Last time had regular check-up	Refused/Don't Know	15 (2.5)	3.1	18 (2.9)	2.2	33 (2.7)	2.9
	Within past year	509 (84.3)	82.0	511(82.8)	81.8	1020 (83.5)	82.0
	1-2 yrs	31 (5.1)	5.1	44 (7.1)	6.8	75 (6.1)	5.6
	2+ yrs	49 (8.1)	9.7	44 (7.1)	9.1	93 (7.6)	9.6
Blood stool test using a home kit (Ever)	Don't Know	5 (0.8)	0.8	5 (0.8)	0.8	10 (0.8)	0.8
	No	392 (64.9)	68.0	376 (60.9)	62.7	768 (62.9)	66.5
	Yes	207 (34.3)	31.2	236 (38.3)	36.5	443 (36.3)	32.7
How long since last blood stool test with home kit	Don't Know	7 (3.4)	4.1	9 (3.8)	3.7	16 (3.6)	1.4
	Past yr	70 (33.8)	30.6	115 (48.7)	47.4	185 (41.8)	35.8
	2 yrs	32 (15.5)	16.1	42 (17.8)	19.8	74 (16.5)	17.3
	2-3 yrs	21 (10.1)	10.7	19 (8.1)	7.5	40 (9.0)	9.7
	3-5 yrs	27 (13.0)	12.3	10 (4.2)	3.4	37 (8.4)	9.5
	>5 yrs	50 (24.2)	26.2	41 (17.4)	18.2	91 (20.5)	23.7
Any blood stool tests returned with abnormal- positive	Don't Know	3 (1.5)	1.5	3 (1.3)	1.4	6 (1.4)	1.4
	No	392 (64.9)	68.0	376 (60.9)	62.7	768 (62.9)	66.5
	Yes	8 (3.9)	3.2	19 (8.1)	10.2	27 (6.1)	5.4
	Referred for colonoscopy	2 (25.0)	12.4	5 (26.3)	33.6	7 (25.9)	24.9
	Received results only	0 (0.0)	0.0	2 (10.5)	20.0	2 (7.4)	11.8
	Scheduled colonoscopy but did not go	0 (0.0)	0.0	1 (5.3)	1.6	1 (3.7)	0.9
	Had colonoscopy	6 (75.0)	87.6	9 (47.4)	32.2	15 (55.6)	54.9
	Other	0 (0.0)	0.0	2 (10.5)	12.6	2 (7.4)	7.4
Ever had sigmoidoscopy or colonoscopy	No	128 (21.2)	25.6	146 (23.7)	27.3	274 (22.4)	26.1
	Yes	476 (78.8)	74.4	468 (75.9)	72.2	944 (77.3)	73.8
Most recent exam sigmoidoscopy or colonoscopy	Sigmoidoscopy	8 (1.7)	1.4	10 (2.1)	2.5	18 (1.9)	1.7
	Colonoscopy	467 (98.1)	98.3	456 (97.4)	97.1	923 (97.8)	98.0
	Don't Know	5 (1.1)	1.0	8 (1.7)	1.6	13 (1.4)	1.2
Time since last sigmoidoscopy or colonoscopy	Past yr	111 (23.3)	25.3	113 (24.2)	28.4	224 (23.7)	26.1
	Past 2 yrs	71 (14.9)	14.8	91 (19.4)	18.5	162 (17.2)	15.8
	Past 3 yrs	69 (14.5)	13.7	64 (13.7)	14.5	133 (14.1)	13.9
	Past 5 yrs	100 (21.0)	22.8	83 (17.7)	16.7	183 (19.4)	21.1
	Within past 10 yrs	89 (18.7)	17.6	84 (18.0)	16.3	173 (18.3)	17.2
	>10 years	31(6.5)	4.9	25 (5.3)	3.9	56 (5.9)	4.6
	Don't Know	4 (0.8)	0.7	5 (1.1)	0.9	9 (1.0)	0.8
Any sigmoidoscopy or colonoscopy returned abnormal-positive	No	399 (83.8)	82.1	403 (86.1)	87.5	802 (85.0)	83.5
	Yes	73 (15.3)	17.2	60 (12.8)	11.7	133 (14.1)	15.7
	Don't Know	3 (0.6)	0.6	2 (0.4)	0.6	5 (0.5)	0.6
Have you ever been told you have colon polyps or have polyps been removed	No	227 (47.7)	47.4	239 (51.1)	51.8	466 (49.4)	48.3
	Yes	246 (51.7)	51.9	227 (48.5)	48.6	473 (50.1)	51.0
*Note: Percentages may not total 100 due to missing data							

Table 3. Self-Reported Reasons for Never Having CRC Screening by Study Area

		Ohio counties		Kentucky counties		Total	
		Unweighted Frequency (Percent)	Weighted Percent	Unweighted Frequency (Percent)	Weighted Percent	Weighted Frequency (Percent)	Weighted Percent
Most Important reason never had colorectal cancer screening	Personal – knowledge, attitudes, fears, etc.	55 (62.5)	66.2	55 (58.5)	65.7	110 (60.4)	66.1
	Provider – interactions with providers, recommendations	10 (11.4)	9.8	12 (12.8)	9.7	22 (12.1)	9.8
	Barrier – factors hindering screening	10 (11.4)	12.8	12 (12.8)	13.7	22 (12.1)	13.0

Table 4. Adherence with CRC Screening Guidelines by Demographic Characteristics and Self-Reported Screening Status*

Variable	Level	Not Adherent (n=268, 22.0%)	Adherent (n=952, 78.0%)	Unadjusted OR (95% CI)	Main Effects *p*-value**
Age	50-54	61 (47.7)	89 (52.3)	Reference	<0.001
	55-59	59 (24.3)	170 (75.7)	2.84 (1.55, 5.20)	
	60-64	55 (19.1)	222 (80.9)	3.86 (2.11, 7.06)	
	65-69	52 (21.3)	350 (78.7)	3.37 (1.85, 6.14)	
	70-74	41 (12.4)	231 (87.6)	6.45 (3.43, 12.17)	
Sex at birth	Male	106 (30.6)	313 (69.4)	Reference	0.007
	Female	162 (20.8)	638 (79.2)	1.68 (1.15, 2.45)	
Race	Non-White	16 (35.2)	38 (64.8)	Reference	0.253
	White	250 (24.9)	911 (75.1)	1.64 (0.70, 3.80)	
Marital status	Married/living w partner (reference)	178 (26.0)	641 (74.0)	Reference	0.006
	Divorced/separated/widowed	67 (19.9)	258 (80.1)	1.41 (0.90, 2.21)	
	Never been married	23 (44.0)	49 (56.0)	0.45 (0.23, 0.85)	
Education	< High School	34 (28.4)	54 (71.6)	Reference	0.274
	High School/GED	105 (28.1)	343 (71.9)	1.06 (0.52, 2.18)	
	Some college or associate degree	72 (27.3)	262 (72.7)	1.02 (0.52, 1.97)	
	Bachelor's degree or more	56 (19.8)	291 (80.2)	1.61 (0.79, 3.29)	
Health Insurance	Uninsured	25 (63.8)	16 (36.2)	Reference	<0.001
	Public	124 (21.9)	533 (78.1)	6.29 (2.62, 15.11)	
	Private	110 (27.8)	325 (72.2)	4.58 (1.87, 11.25)	
	Other	8 (12.5)	64 (87.5)	12.35 (3.05, 50.08)	
Household income:	< $15,000	32 (30.3)	86 (69.7)	Reference	0.719
	$15,000 to $24,999	36 (29.8)	120 (70.2)	1.02 (0.48, 2.16)	
	$25,000 to $34,999	13 (18.2)	86 (81.7)	1.95 (0.75, 5.10)	
	$35,000 to $49,999	40 (26.7)	119 (73.3)	1.19 (0.57, 2.52)	
	$50,000 to $74,999	33 (28.1)	128 (71.9)	1.11 (0.52, 2.38)	
	$75,000+	45 (23.2)	186 (76.8)	1.44 (0.67, 3.07)	
Have a provider	No (reference)	47 (74.75)	28 (25.25)	Reference	<0.001
	Yes (1 or more)	221 (20.78)	924 (79.22)	11.29 (5.67, 22.48)	
Last time you had regular check-up	2+ years ago	55 (69.6)	37 (30.4)	Reference	<0.001
	Within past year	174 (18.5)	846 (81.5)	10.03 (5.43, 18.77)	
	Past 1-2 years	18 (23.3)	57 (76.7)	7.52 (2.77, 20.44)	
Smoke cigarettes every day, some days or not at all	Have not Smoked 100 cig. (reference)	133 (27.8)	475 (72.2)	Reference	0.129
	Previous Smoker	71 (19.6)	311 (80.4)	1.58 (1.02, 2.46)	
	Currently Some Days	9 (23.6)	45 (76.4)	1.25 (0.47, 3.31)	
	Currently Every day	55 (30.4)	121 (69.6)	0.89 (0.52, 1.50)	
Have at least one first degree relative with CRC	No	232 (26.7)	808 (73.3)	Reference	0.095
	Yes	36 (18.5)	144 (81.5)	1.61 (0.92, 2.82)	
Ever been told you have cancer	No	240 (28.3)	718 (71.7)	Reference	0.002
	Yes	28 (13.1)	234 (86.9)	2.61 (1.42, 4.82)	

*Note: Percentages may not total 100 due to missing data
**Test of any difference in adherence across the levels of a variable

importance of outreach for follow-up screening for patients who use stool-based modalities [21,22].

Of respondents who reported being nonadherent to screening guidelines, nearly 67% cited intrapersonal factors such as knowledge, attitudes, and fear as barriers. A substantial literature exists noting a high prevalence of intrapersonal factors as reasons for not getting screened, as has our own formative research for ACCSIS [23]. Community and systemic barriers are also pervasive in Appalachian Kentucky and Ohio. In key informant interviews we found that factors such as transportation, financial concerns (out-of-pocket expense), and competing priorities were barriers to CRC screening [13]. In the present survey, nearly 15% of respondents cited cost and transportation as barriers. Lack of insurance (or underinsured) is a barrier to screening and those without a usual source of care, although underrepresented in our findings, are likely to experience barriers more often and at a greater magnitude. Finally, 10% cited lack of provider recommendation as a reason for not being screened. Studies have shown that provider recommendation is a strong predictor of both screening in general and screening via provider-recommended modalities and that the provision of screening information and shared decision making are particularly effective communication methods [24-26].

Table 5. Multivariable Associations between CRC Screening within Guidelines and Respondent Characteristics.

Variable	Level	Adjusted OR (95% CI)	Main Effects *p*-value*
Age	50-54	Reference	<0.001
	55-59	2.34 (1.25, 4.39)	
	60-64	3.07 (1.64, 5.74)	
	65-69	2.59 (1.42, 4.72)	
	70-74	3.82 (1.97, 7.40)	
Gender	Male	Reference	0.048
	Female	1.52 (1.01, 2.29)	
Marital status	Married/living w partner	Reference	0.044
	Divorced/separated/widowed	1.51 (0.91, 2.50)	
	Never been married	0.51 (0.23, 1.14)	
Have a healthcare provider	No	Reference	0.001
	Yes (1 or more)	3.33 (1.61, 6.86)	
Last time you had regular check-up	2+ years	Reference	<0.001
	Within past year	4.87 (2.63, 9.03)	
	1-2 years	4.31 (1.47, 12.58)	
Ever been told you have cancer	No	Reference	0.038
	Yes	1.93 (1.04, 3.59)	
*Test of any difference in adherence across the levels of a variable			

Additional research is needed to broaden and deepen understanding of barriers to CRC screening in the population at large and particularly in the Appalachian population. Many of the counties surveyed have historically had some of the lowest screening rates in their respective states [27] and while the results from this survey have identified factors associated with the low rates, the non-response rate suggests that the picture remains incomplete. It is important that effort be expended by researchers to investigate novel methods to reach non-responders to determine if they differ significantly in their screening behaviors from those who responded to the survey. Should these groups differ significantly and substantially, additional outreach would be warranted, particularly with subpopulations less likely to get screened (e.g., lower income, lower educational attainment, women, no usual source of care, and younger age).

The survey results reported here are limited by several factors, including the response rate by those at the younger end of the age range of the survey. The results are also limited by the inherent nature of telephone survey methodology and how it has changed with the increase in cell phone use. While rural populations have adopted cell phones at a lower rate than urban and suburban populations, over time the proportion of residents relying on cell phones has increased. Sampling protocols for the BRFSS survey were previously limited to landlines and a sampling frame could be identified that would have a high probability of including residents of the intended geographical areas. As cell phone use has increased, the protocols for random digit dialed sampling have evolved as have concern about the validity of survey results [28].

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Conflicts of Interest/Competing Interests

None of the authors has a competing interest to report.

Ethics Approval and Consent to Participate

All portions of this study were approved by the institutional review board of The Ohio State University and the Office of Research Integrity at the University of Kentucky.

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