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Multilevel small area estimation for county-level prevalence of colorectal cancer screening test use in the United States using 2018 data

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Abstract

Purpose—: National screening estimates mask county-level variations. We aimed to generate county-level colorectal cancer (CRC) screening prevalence estimates for 2018 among adults aged 50–75 years and identify counties with low screening prevalence.

Methods—: We combined individual-level county data from the 2018 Behavioral Risk Factor Surveillance System (BRFSS) (*n* = 204,947) with the 2018 American Community Survey county poverty data as a covariate, and the 2018 U.S. Census county population count data to generate county-level prevalence estimates for being current with any CRC screening test, colonoscopy, and home stool blood test. Because BRFSS is a state-based survey, and because some counties did not have samples for analysis, we used correlation coefficients to test internal consistency between model-based and BRFSS state estimates.

Results—: Correlation coefficients tests were ≥0.97. Model-based national prevalence for any test was 69.9% (95% CI, 69.5% −70.4%) suggesting 30% are not current with screening test use. State mean estimates ranged from 62.1% in Alaska and Wyoming to 76.6% in Maine and Massachusetts. County mean estimates ranged from 42.2% in Alaska to 80.0% in Florida and Rhode Island. Most tests were performed with colonoscopy.

Conclusions—: Estimates across all U.S. counties showed large variations. Estimates may be informative for planning by states and local screening programs.

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Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention or the U.S. Bureau of Labor Statistics.

Keywords

Colorectal cancer screening; Colorectal cancer screening prevalence; Fobt; Fit; Small area estimation; County-level estimates

Introduction

The U.S. Preventive Services Task Force (USPSTF) recommended in 2016 routine screening of adults aged 50–75 years for colorectal cancer (CRC). Screening for colorectal cancer saves lives via early detection and removal of precancerous polyps and early stage cancers [1]. In 2021, the National Institute of Health estimated a total of 149,500 new cases of colorectal cancer and 52,980 deaths from colorectal cancer, comprising 7.9% and 8.7% of all new cancer cases and all cancer deaths respectively [2]. Premature death from CRC in the United States is largely driven by racial/ethnic, educational attainment, and geographical inequalities [3,4]. Emerging evidence of increasing CRC cases among adults aged 45–49 years, prompted the USPSTF in 2021 to revise its previous recommendations to include screening adults in this age group [5], similar to the recommendations published by the American Cancer Society in 2020 [6].

In 2018 the national prevalence of being current with colorectal cancer screening using data from the Behavioral Risk Factor Surveillance System (BRFSS) was 68.8% [3], indicating that approximately one in 3 adults eligible for screening had not received it. A slightly lower result, 66.9%, was also observed using data from the 2018 National Health Interview Survey (NHIS) albeit with a different methodology [7,8]. These findings are lower than the National Colorectal Cancer Roundtable (NCCRT) 2018 goal of 80% [9], and lower than the 74.4% target for Healthy People 2030 [10], albeit measured by a different methodology. The goal of our study is to examine socio-geographic variations in colorectal cancer screening among adults aged 50–75 years by generating county-level prevalence estimates which are masked by aggregating data to state or national estimates [11]. Although national CRC screening rates have been increasing over time [3,7,8], understanding more granular geographic differences in screening use can inform decision-making on resource allocation to improve screening uptake in areas with low screening prevalence.

Materials and methods

We used data from the 2018 BRFSS restricted data set after adding state and county of residence information to each BRFSS respondent aged 50–75 years. The BRFSS is a state-based, random-digit-dial survey of noninstitutionalized adults aged 18 years or older administered by the Centers for Disease Control and Prevention (CDC) in collaboration with 50 state health departments, the District of Columbia, and two territories [12]. The combined landline and cell phone weighted response rates in 2018 ranged from 38.8% in California to 67.2% in South Dakota, with a median rate of 49.9% [12].

BRFSS respondents aged 50 years or older were asked whether they had at least one of 3 CRC tests. Each of the tests was described to help the respondent identify the test. A home tool blood test was described as a test using a home kit, to determine whether the stool contains blood. To better match our study to the updated recommendations and a previous 2020 study using 2018 BRFSS data [3], we considered home stool blood test as either a guaiac-based fecal occult blood test (FOBT) or a fecal immunochemical test (FIT). Sigmoidoscopy, or colonoscopy were described as exams in which a tube is inserted in the rectum to view the colon for signs of cancer or other health problems [3,12]. Respondents who answered "yes" to any of these tests were further asked how long it had been since their most recent test.

We defined respondents to be current with any CRC screening test if they reported at least one of the following tests: home stool blood test within one year, sigmoidoscopy within 5 years, or colonoscopy within 10 years, consistent with 2016 USPSTF recommendations for these tests [1]. Respondents reporting not receiving these tests within the recommended time interval, or never having had any of the above tests, were considered not current. We used 2016 USPSTF CRC screening recommendations in defining up to date with screening and to determine the age group to be 50–75 years because only data for adults aged 50 years or older were collected in 2018. BRFSS data did not include other USPSTF recommended tests or had insufficient data for analysis.

BRFSS did not ask for the reasons for screening. Therefore, our CRC analysis is not considered as a specific measure of screening but as a general measure of test use and might include diagnostic tests. However, some of the persons who underwent diagnostic tests might be considered effectively screened as reported in a previous study [7].

Statistical analysis

We used a BRFSS sample of 204,947 adults. We linked the individual data with the American Community Survey (ACS) 5-year county-level poverty rate estimates (2014–2018) of <150% of the federal poverty rate [13], received from the U.S. Census, and fitted the following 3 separate multilevel logistic regression mixed models:1) any of the 3 CRC screening tests, 2) colonoscopy, and 3) home stool blood test. The poverty level is included as a county covariate describing the percentage of each county population being under 150% of the federal poverty rate. We chose the poverty level measure of <150% for analysis because it had a better prediction power for small area estimation for chronic disease outcomes then the lower level of <100%. The multilevel logistic regression models had fixed and random effects [11]. Fixed effects included 5 age groups (50–54, 55–59, 60–64, 65–69, 70–75), 7 racial and ethnic groups, (non-Hispanic (NH) White, NH Black, NH American Indian/Alaska Native (AIAN), NH Asian, NH Pacific Islander, NH 2 or more races, and Hispanic), and county-level poverty. The variables state and county were included as random effects. We included all adults in our analysis and excluded the category "NH other race" to match the variable race and ethnicity to the Census data respective variable, which we later used in our simulations. Because this race category comprised a very small percentage (0.5%) of the race and ethnicity variable, its removal had no substantial effect on the outcome of any CRC test type. We fitted the multilevel logistic regression models with unweighted data using the GLIMMIX procedure, SAS version 9.4 (SAS Institute, Inc., Cary, NC). Our models used unweighted data because validation studies have shown higher estimates' accuracy with unweighted than with weighted data [14,15].

Because BRFSS did not have data for analysis in some counties, most often in rural areas, the GLIMMIX results for these counties did not include random effects. Therefore, we generated the missing county-level random effects by averaging the neighboring counties' random effects, a method based on previous studies [16,17]. This technique is flexible and avoids over-smoothing outcomes from adjacent counties and enables analysis of BRFSS counties with no data.

To align the BRFSS county data more closely with the U.S. Census data, we post-stratified the predicted probability of having each CRC screening test type for the 5 age groups × 7 race and ethnicity groups × 3142 counties with 2018 U.S. Census estimated county population counts [18]. The post-stratified data including the complete list of random effects and the estimated parameters from each model were used in newly constructed Monte Carlo simulation programs. Each simulation consisted of 1000 randomly drawn samples for each of the parameters and their standard errors to predict the individual-level expected probability of being current with the respective CRC screening type. County-level random effects denote their contextual effect on the outcome.

Our multilevel logistic regression models followed the generalized linear mixed models' general formula [11]:

$$\mathrm{P_{ijcs}}(\mathrm{y_{ijcs}} = 1) = \mathrm{logit}^{-1}(\alpha_\mathrm{i} + \gamma_\mathrm{j} + \mathrm{x'}_\mathrm{c}\eta + \mu_\mathrm{c} + \mathrm{v_s})$$

$\mathrm{y_{ijcs}}$ is the self-reported screening status (1=current, 0=not current or never been screened) for an individual in age group i, $i = 1$ to 5, and race/ethnicity group j, $j = 1$ to 7, from county c in state s, and their respective regression coefficients. x_c is a vector of county-level covariates and η is a vector of their respective regression coefficients. The prediction model included a product of the county-level poverty status $x_c^{'}$ and its respective regression coefficient η. μ_c, and $\mathrm{v_s}$ are the county- and state-level random effects, which were assumed to be independent and normally distributed.

Our simulation models estimated the expected probability of an individual in each of the geodemographic groups being current with each of these test types in each of the 3142 US counties. We then aggregated the specific geodemographic group prevalence estimates for each of the 3 screening types to generate predicted mean values, their standard errors, and 95% confidence intervals by county, by state and for the entire United States.

For example, let $P^1{}_{cs}$ = the county-level estimated prevalence of being current with any test use in county c in state s, P_{ijcs} = the individual probability of being in age group i, and race or ethnicity group j, in county c and state s, Pop_{ijcs} = the respective population count, and Pop_{cs} = the total population count in county c in state S,

$$\text{then } P^1{}_{cs} = \left[\sum_i \sum_j \left(P_{ijcs_X} Pop_{ijcs}\right)\right] / \sum_i \sum_j \left(Pop_{ijcs}\right) = \left[\sum_i \sum_j \left(P_{ijcs_X} Pop_{ijcs}\right)\right] / Pop_{cs}$$

Similarly, let $P^2{}_{cs}$ = the county-level prevalence of not being current with CRC screening or never been screened for CRC in county c within state s,

$$then\ P^2{}_{cs} = \left[\sum_i \sum_j ((1 - P_{ijcs})_X Pop_{ijcs})\right] / Pop_{cs}$$

We calculated summary statistics for the model-based county distributions with the univariate procedure. Summary statistics for state estimates for the 2018 BRFSS direct estimates were calculated with the MEANS and univariate procedures. We do not present results for sigmoidoscopy alone because few adults reported this procedure.

Because the BRFSS is a state-based surveillance system, we validated the internal consistency between the BRFSS and the model-based state estimates with Spearman and Pearson correlation coefficients. We were not able to validate internal consistency of all counties because BRFSS had missing sample information in some counties. However, in a previous validation of county internal consistency which included only counties with a population size of 500 or more adults [11], the Spearman and Pearson correlation coefficients were ≥0.86. We used ESRI ArcGIS 10.8.1 (Esri, Redlands, CA) to separately map the model-based county estimates for each of the estimated percentages of being current with any CRC screening test, with colonoscopy, and with home stool blood test. The multilevel simulation models were fitted with SAS Ver. 9.4. BRFSS states summary estimates calculations for internal consistency were performed with SAS-callable SUDAAN (Research Triangle Institute, Research Triangle Park, NC).

Results

Our post-stratified model-based national prevalence estimates for being current with any type of CRC screening test, colonoscopy, or home stool blood test were very similar to the 2018 direct BRFSS national prevalence estimates, each with 95% CI's partly overlapping (Table 1). The prevalence estimates were almost 70.0% for any CRC screening test type, 64.9% for colonoscopy, and 11.1% for home stool blood test.

A comparison between model-based state summary statistics for the three CRC screening analyses and those of the direct (weighted) BRFSS estimates show very similar means and medians (Table 1). The overall ranges of BRFSS state estimates were larger than those of the model-based estimates. However, the Spearman and Pearson correlation coefficients between survey and model-based state prevalence estimates were ≥0.97 for all CRC screening types. Model-based state prevalence of any CRC screening test use varied from 62.1% in Alaska and Wyoming to 76.6% in Massachusetts and Maine (Tables 1 and 2, and Fig. 1A). Colonoscopy testing varied from 57.3% in Nevada and 57.7% in Alaska to 73.2% in Massachusetts and Connecticut (Tables 1 and 2, and Fig. 1B). Home stool blood test use varied from 4.5% in Utah to 19.7% in California and 20.6% in Hawaii (Tables 1 and 2, and Fig. 1C), a prevalence nearly twice the national home stool blood test prevalence of 11.1%. Connecticut, Maine, Massachusetts, Michigan, Minnesota, Wisconsin, Rhode Island, and the district of Columbia, had their county mean estimate for any CRC screening type exceeding 74%, while the county mean estimate in New Hampshire and Vermont where slightly lower at 73.8% (Table 2). In 8 of these states, county means of colonoscopy were at least 70% with New Hampshire following at 69.9%.

States with the lowest county mean estimate (≤65.0%) for any CRC screening type included Alabama, Mississippi, Oklahoma, Arkansas, Texas, New Mexico, Arizona, Nevada, and Wyoming. Kansas, Nebraska, and Montana had their county mean estimate slightly higher at ≤65.3%. Seven of these states and Hawaii had their county mean estimate for colonoscopy at ≤60.0% with Wyoming at 60.1%.

Two-thirds (n = 34) of the states had their county mean estimate for home stool blood test at ≤10.0%. County mean estimates for Vermont, New Hampshire, Delaware, Wisconsin, Iowa, Kansas, Nebraska, Utah, and Wyoming were ≤7.0%.

The large variation in county prevalence is often indicated by the range of county estimates in each state and differences in these ranges among states. Eighteen states had at least a 15-percentage point difference in prevalence estimates for any CRC test between counties with the lowest and the highest percentages; Alaska, North Dakota, South Dakota, and New Mexico had more than a 25-percentage point difference. About half of the states (n = 26) had overall county ranges ≥15.0% for colonoscopy and 5 exceeded 25.0%. The largest ranges among the states for home stool blood test were in California (10.3%) and Hawaii (11.5%), the states with the highest prevalence estimate of these tests.

Discussion

Our 2018 national prevalence estimate of any CRC screening (70.0%) is close to the HP2030 target of 74.4% [10] although this target is based on a lower estimate using the 2018 NHIS.

This result is a moderate increase nationally in any CRC screening test use from 67.3% in 2014, derived from a similar modeling approach using BRFSS data [11]. Model-based colonoscopy use between these years increased from 63.7% to 64.9% and home stool blood test, from 9.7% to 11.1%. Nevertheless, nationally and by states, being current with CRC screening use is still far from the "80% by 2018″ NCCRT goal in every community [9]. Progress toward meeting the HP2030 screening target of 74.4% demonstrates some regional patterns. The highest screening prevalence of any test was seen in the Northeast (Maine, Massachusetts, Connecticut, and New Hampshire), North (Michigan, Minnesota, and Wisconsin), and Washington DC where states reached or surpassed the HP2030 goal. While all other states did not achieve this goal in 2018, Alaska, Wyoming, New Mexico, and Arizona had the lowest screening state prevalence for any test at <62.0%. Similar findings to those with the lowest screening prevalence were also observed in our 2014 study with the addition of Idaho and Arkansas [11]. Also, 21 counties in 2014 versus 9 in 2018 had their mean county estimates at ≤65.0%, indicating a positive change in CRC screening. States with the lowest screening prevalence, as well as other states have large rural areas or diverse population, with some experiencing difficulty obtaining health care access due to health professional shortage, living in low income areas, or difficulty in obtaining culturally sensitive health care information [19,20,21]. A previous national study found that CRC screening use is lower among persons without health insurance, those without a regular health care provider, those who are Hispanic, non-Hispanic AIAN, non-Hispanic Asian or Pacific Islanders, those with lower education levels, those with lower incomes, and those who live in non-metropolitan areas [3].

Although colonoscopy comprised most screening, some states also experienced relatively substantial screening with home stool blood test, including Hawaii, California, and Florida. Compared with 2014 [11], prevalence in Hawaii and California increased to nearly twice the national prevalence possibly indicating health care providers or organization preferences [22]. USPSTF recommendations include multiple options, and uptake may be encouraged if individuals can choose the test they prefer. To increase screening uptake, some health plans encourage the use of these tests by mailing kits to select members [22,23]. Other possible explanations for the increase in stool tests may include a higher use among older adults who participate in Medicare Advantage in health maintenance organizations (HMOs) [24]. Medicare Advantage plans receive from Medicare a capitated (per enrollee) amount to provide all Part A and B benefits financially incentivizing them to promote the less expensive test instead of the more expensive and invasive colonoscopy [23]. Higher co-morbidity may also drive provider and patients to increase the use of stool tests. However, to realize the benefit of stool tests, positive results need to be followed by colonoscopy [24]. Increasing awareness of the various CRC screening choices with discussion of their benefits and possible harms may also increase screening uptake. Additionally, as screening use expands into younger age groups with the new USPSTF recommendations, these methods could be extended to include those ages as well. However, to study the inclusion effect of adults aged 45–49 years on CRC screening, the necessary information from BRFSS and other data sources needs to be available.

Limitations

Findings are subject to several limitations. First, our analysis depended on self-reported data on screening and was not verified with medical records. Second, BRFSS did not collect information about other, less common CRC tests recommended by USPSTF. However, some of these tests are relatively new and rarely used in 2018 [8]. Lastly, because BRFSS does not specify whether the tests were done for screening or diagnostic purposes, screening use might be overestimated. Nevertheless, our findings suggest large proportions of residents in many counties are not current with screening and show large variations in CRC screening use among counties and states, which are not often presented.

Conclusions

Despite a small improvement in screening uptake, we found that in 2018, on average, three in ten adults were not current with CRC screening according to USPSTF recommendation. We found large disparities in CRC screening use across counties. County-level estimates can help states and local screening programs identify counties with low CRC screening use. Culturally appropriate programs tailored to the needs of the local populations and increasing awareness and education about the different screening choices can potentially reduce CRC screening gaps and contribute to a higher uptake.

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Glossary

BRFSS	Behavioral Risk Factor Surveillance System
USPSTF	United States Preventive Services Task Force
FOBT	fecal occult blood test
FIT	fecal immunochemical test
CRC	colorectal cancer
NHIS	National Health Interview Survey
NCCRT	National Colorectal Cancer Roundtable
HP2030	Healthy People 2030
CDC	Centers for Disease Control and Prevention
ACS	American Community Survey
NH	Non-Hispanic
AIAN	American Indian/Alaska Native

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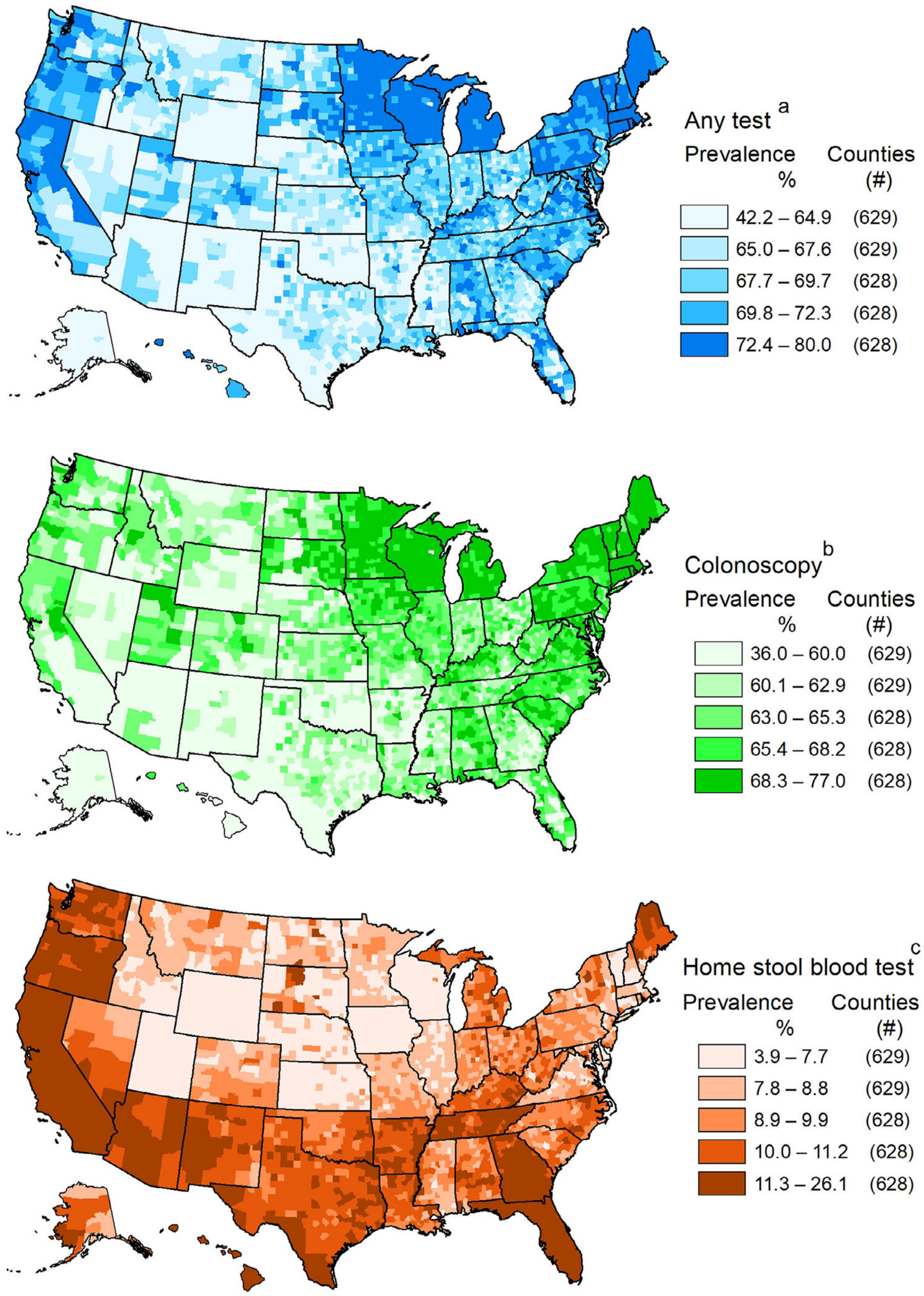

Fig. 1.

Model-based county estimated prevalence (%) maps for being current with three colorectal cancer test types: (A) any colorectal cancer test type, (B) colonoscopy within 10 years, and (C) home stool blood test within the past year. Any colorectal cancer test type includes home stool blood test within the past year such as a fecal occult blood test (FOBT) or fecal immunochemical test (FIT); sigmoidoscopy within 5 years; or colonoscopy within 10 years. The map for each test type sorts the 3142 total counties into county quintiles.

Table 1

Comparisons of model-based national and state's summary statistics prevalence estimates (%) and direct BRFSS 2018 prevalence estimates (%) of three CRC testing types: any type, Colonoscopy, and Home stool blood test, and Spearman and Pearson correlation coefficient

Test type	Model-based					BRFSS						
	National prevalence					National prevalence						
Any	69.9 (69.5–70.4)					69.4 (68.9–69.9)						
Colonoscopy	64.9 (64.4–65.4)					64.0 (63.5–64.5)						
Home stool blood test	11.1 (10.8–11.4)					11.5 (11.2–11.8)						
	States (n = 51) Summary statistics					**States (n = 51) summary statistics**					**Correlation coefficient**	
	Mean	Min	Median	Max	Range	Mean	Min	Median	Max	Range	Spearman	Pearson
Any	70.1	62.1	70.4	76.6	14.5	69.5	59.0	69.9	77.2	18.2	0.97	0.97
Colonoscopy	65.6	57.3	65.1	73.2	15.9	64.9	54.2	64.3	73.5	19.3	0.97	0.97
Home stool blood test	9.6	4.5	9.0	20.6	16.1	9.6	3.8	8.9	22.1	18.3	0.98	0.99
	Counties (n = 3142) Summary s											
	Mean	Min	Median	Max	Range							
Any	68.4	42.2	68.6	80.0	37.8							
Colonoscopy	63.8	36.0	64.2	77.0	41.0							
Home stool Blood test	9.7	3.9	9.3	26.1	16.4							

Table 2

Model-based SAE state estimated mean (%) and county statistics summarized by state for being current with any colorectal cancer test Type, home stool blood test, and colonoscopy

State	Any colorectal test type								Home stool blood test							
	State	County Summary statistics							State	County summary statistics						
	Mean	Min	Q1	Mean	Median	Q3	Max	Range	Mean	Min	Q1	Mean	Median	Q3	Max	Range
Alabama	71.8	64.7	68.8	70.2	70.2	72.1	74.0	9.4	9.7	8.0	9.3	10.1	9.9	10.6	13.0	5.0
Alaska	62.1	42.2	56.4	59.4	60.0	63.8	68.0	**25.7**	8.5	7.4	8.1	9.2	8.9	9.8	13.0	5.5
Arizona	66.8	49.0	58.7	61.5	61.4	65.2	68.9	**19.9**	11.9	10.2	11.1	12.0	11.6	12.5	15.6	5.5
Arkansas	67.1	59.9	63.3	65.0	65.3	66.7	76.4	**16.5**	10.7	8.9	10.6	11.2	11.1	11.6	13.1	4.2
California	71.0	61.7	69.9	72.2	72.7	74.8	79.4	**17.7**	19.7	15.2	17.8	18.7	18.5	19.6	25.5	10.3
Colorado	69.8	56.6	66.1	67.8	68.3	69.9	73.6	**17.0**	8.8	6.6	8.3	8.9	8.9	9.4	11.0	4.4
Connecticut	75.7	73.3	75.6	76.1	76.4	76.8	78.1	4.7	8.2	6.4	7.2	7.8	7.6	8.1	9.9	3.5
Delaware	72.2	70.6	70.6	72.4	70.7	75.8	75.8	5.1	6.9	6.7	6.7	6.9	6.8	7.2	7.2	0.5
Washington DC	74.6			74.6					13.4			13.4				
Florida	69.7	60.3	67.4	69.7	69.9	72.3	80.0	**19.7**	15.9	12.0	14.5	15.5	15.3	16.7	20.1	8.0
Georgia	68.8	61.0	65.5	67.4	67.5	69.3	75.8	14.8	12.6	9.7	12.0	12.9	12.9	13.7	15.7	6.0
Hawaii	73.6	65.8	68.5	70.6	70.6	72.9	75.4	9.7	20.6	14.5	19.6	21.2	20.4	25.5	26.1	11.5
Idaho	67.2	58.3	63.5	65.9	66.4	67.9	72.6	14.3	7.3	6.6	7.2	7.6	7.6	7.9	8.3	1.6
Illinois	67.6	64.8	68.0	69.0	69.0	70.2	73.4	8.6	7.9	6.5	7.6	7.8	7.8	8.1	9.4	2.9
Indiana	68.8	63.5	66.9	68.2	68.3	69.3	74.3	10.7	9.3	7.6	8.7	9.1	9.0	9.3	10.9	3.3
Iowa	71.1	66.3	68.7	70.4	70.6	71.7	74.5	8.2	6.8	5.9	6.4	6.7	6.6	6.9	8.2	2.3
Kansas	67.5	54.0	64.3	65.3	65.7	67.1	74.0	**19.9**	7.0	6.2	7.1	7.3	7.3	7.6	8.9	2.7
Kentucky	71.5	62.3	68.5	70.3	70.4	72.3	76.6	14.3	10.4	8.5	10.0	10.4	10.3	10.8	12.8	4.2
Louisiana	69.1	59.5	65.8	67.6	67.9	69.2	72.6	13.1	10.1	8.2	9.8	10.4	10.3	10.9	13.4	5.2
Maine	76.6	70.6	74.9	75.9	76.2	78.0	78.5	7.8	9.5	7.4	9.7	10.4	10.4	11.0	13.3	5.9
Maryland	72.8	68.3	69.9	71.8	71.7	73.6	75.2	6.9	9.3	6.0	7.3	8.2	8.0	8.7	11.6	5.6
Massachusetts	76.6	72.6	75.5	76.6	77.0	78.2	78.7	6.2	7.9	6.5	7.8	8.1	8.2	8.6	9.0	2.5
Michigan	74.4	71.3	73.5	74.9	74.6	76.4	79.3	8.0	9.9	8.1	9.5	9.9	10.0	10.3	13.0	4.9
Minnesota	75.0	67.0	72.8	74.1	74.2	75.6	78.7	11.7	7.8	6.3	7.6	8.0	8.0	8.3	10.2	3.9
Mississippi	65.3	56.9	62.6	64.0	64.6	65.5	73.6	**16.7**	8.6	7.5	8.2	9.0	8.9	9.7	11.7	4.2

Missouri	70.7	62.5	67.0	68.3	68.1	69.7	75.5	13.0	8.3	6.9	8.3	8.6	8.6	8.9	9.9	3.0
Montana	65.9	51.9	63.9	65.1	65.8	67.4	70.7	**18.8**	8.0	6.9	7.7	8.3	8.1	8.7	10.8	3.9
Nebraska	68.1	57.4	63.2	65.1	65.2	66.9	74.2	**16.8**	7.0	6.1	7.0	7.4	7.3	7.6	11.1	5.0
Nevada	62.5	60.0	62.4	64.5	64.0	66.8	69.9	9.9	11.7	8.4	9.2	10.0	9.9	10.4	12.6	4.2
New Hampshirea Hampshire	74.9	69.1	72.0	73.8	74.1	75.4	77.0	7.9	6.6	5.5	6.3	7.2	7.3	7.9	9.1	3.6
New Jersey	67.8	60.2	65.6	68.0	68.7	70.4	72.4	12.1	8.9	7.5	8.2	8.9	8.8	9.3	10.6	3.0
New Mexico	63.6	44.2	57.9	60.6	60.5	63.3	71.0	**26.7**	10.6	8.0	10.4	11.0	10.9	11.7	13.9	5.9
New York	70.4	64.1	70.8	72.1	72.2	73.7	77.8	13.7	8.4	6.6	8.1	8.9	8.7	9.4	12.6	6.0
North Carolina	70.8	61.8	69.0	70.5	70.6	71.8	76.9	**15.1**	9.4	8.2	9.1	9.8	9.7	10.4	11.7	3.5
North Dakota	68.8	46.7	65.6	66.7	67.6	69.1	73.3	**26.6**	7.4	5.7	7.5	8.1	8.0	8.5	11.5	5.8
Ohio	68.0	60.1	66.1	67.8	68.0	69.5	73.1	13.0	10.2	8.1	9.0	9.6	9.5	10.0	12.2	4.2
Oklahoma	64.1	53.8	60.3	62.1	62.2	64.0	68.7	14.9	10.3	8.6	9.7	10.2	10.1	10.8	18.4	3.8
Oregon	72.6	62.7	69.4	71.0	71.5	72.6	75.7	13.0	12.9	10.6	11.8	12.5	12.5	13.3	16.3	5.7
Pennsylvania	72.6	68.7	71.9	72.6	72.7	73.6	76.7	8.0	9.1	7.9	8.7	9.0	9.0	9.3	10.3	2.3
Rhode Island	76.2	74.6	77.5	77.5	77.7	77.9	80.0	5.4	8.6	7.5	7.9	8.3	8.0	8.6	9.7	2.2
South Carolina	72.3	65.9	69.8	71.2	70.9	72.9	77.3	11.4	9.0	7.3	8.9	9.5	9.3	10.4	11.4	4.1
South Dakota	71.0	45.4	68.8	69.0	71.3	72.8	74.9	**29.5**	7.2	5.5	7.0	7.8	7.3	8.0	13.1	7.6
Tennessee	69.1	64.1	67.2	68.5	68.3	69.5	72.9	8.8	11.3	9.4	11.2	11.7	11.6	12.3	14.5	5.1
Texas	63.6	45.1	62.0	63.9	64.9	66.6	72.5	**27.4**	10.8	9.0	10.4	10.9	10.8	11.3	14.1	5.1
Utah	69.9	58.9	66.9	68.6	69.5	71.1	74.1	**15.2**	4.5	3.9	5.1	5.3	5.3	5.5	6.6	2.7
Vermont	73.8	68.8	71.8	73.8	74.4	75.4	77.7	8.9	6.1	4.7	6.2	6.5	6.8	7.2	8.0	3.3
Virginia	71.1	62.6	68.1	70.2	70.3	72.4	77.0	14.4	8.4	6.8	7.9	8.5	8.5	9.1	10.9	4.0
Washington	71.8	58.9	67.8	70.2	70.9	73.0	75.5	**16.6**	12.2	9.2	10.6	11.6	11.4	12.2	18.0	8.8
West Virginia	70.2	62.6	67.7	69.4	69.3	71.0	74.7	12.0	9.5	7.7	9.3	9.7	9.6	10.2	11.4	3.7
Wisconsin	74.7	61.8	73.1	74.4	74.7	75.8	78.6	**16.8**	6.6	5.5	6.5	6.8	6.8	7.0	9.0	3.5
Wyoming	62.1	57.8	59.0	61.4	60.7	63.5	67.0	9.2	5.8	5.3	5.5	5.9	5.9	6.1	6.7	1.5
Colonoscopy																
State																
	County Summary Statistics															
	State Mean	**Min**	**Q1**	**Mean**	**Median**	**Q3**	**Max**	**Range**								
Alabama	68.1	59.9	64.1	66.2	66	68.3	71.6	11.8								

Alaska	57.7	36.2	50.4	54.3	55.1	59.3	62.6	**26.4**
Arizona	61.8	43	51	54.9	55	59.3	64.4	**21.4**
Arkansas	62.7	53.1	58.1	60	59.5	61.6	74.1	**20.9**
California	61.6	52.3	60.5	63.4	64.5	66.5	69.4	**17.1**
Colorado	64.4	48.9	60	62.2	62.6	64.8	69.9	**20.9**
Connecticut	73.2	70.7	73	73.8	73.9	74.8	76.6	5.9
Delaware	69.0	67.1	67.1	69.1	67.5	72.9	72.9	5.8
Washington DC	68.8			68.8				
Florida	63.3	53.3	60.6	63.3	63.6	66.5	75.7	**22.4**
Georgia	63.7	54.7	60	62.2	62.2	64.2	72	**17.4**
Hawaii	61.6	50.6	53.5	58.4	58.8	63.6	65.5	14.9
Idaho	63.8	54.5	59.3	62.1	63.1	64.2	68.8	14.4
Illinois	63.7	60.7	64.3	65.4	65.2	66.5	70.9	10.2
Indiana	63.8	58.4	61.6	63	63	64.4	69.5	11.2
Iowa	68.0	62.1	65.4	67.3	67.5	68.8	71.9	9.8
Kansas	64.6	50.7	60.5	62	62.5	64.2	71.4	**20.7**
Kentucky	67.5	57.1	63.9	66.1	66.5	68.3	73.5	**16.4**
Louisiana	64.3	53.3	60.8	62.6	63	64.5	68.8	**15.6**
Maine	72.2	65.3	69.5	70.9	70.8	72.9	75.6	10.3
Maryland	68.8	64.2	66.3	68.4	68.4	70.4	72.3	8.1
Massachusetts	73.2	68.7	71.5	73.3	73.4	75.2	76	7.3
Michigan	69.9	65.4	68.6	70.1	69.5	72.2	76.1	10.7
Minnesota	70.8	61.9	68	70	70.5	71.6	75.1	13.2
Mississippi	62.3	53	58.9	60.7	61.1	62.8	72.1	**19.2**
Missouri	66.6	56.9	62	63.9	63.8	65.6	72.06	**15.1**
Montana	61.2	46.2	58.7	60.1	60.5	62.8	65.9	**19.7**
Nebraska	65.1	50.3	59.9	61.8	62.1	63.9	72.1	**21.8**
Nevada	57.3	54.9	56.6	59.2	57.4	61.5	66.7	11.8
New Hampshire	71.5	63	69	69.9	70.3	71.5	74.3	11.2
New Jersey	63.9	55.9	61.7	64.0	65.2	66.6	69.9	14
New Mexico	57.9	36	51.7	54.7	55.0	56.6	67.8	**31.8**
New York	67.0	60.5	66.3	68.4	68.2	70.6	75.3	14.8

North Carolina	67.2	57.3	64.9	66.6	66.7	68.3	74.7	**17.4**
North Dakota	65.3	41.2	61.6	62.6	63.7	65.1	71.1	**29.9**
Ohio	63.0	52.5	61.3	63	63.3	65.2	70.7	**18.2**
Oklahoma	59.6	48.8	55.3	57.5	57.7	59.3	66.6	**17.8**
Oregon	64.7	54.2	61.1	63.2	63.6	65.2	69.2	**15**
Pennsylvania	68.3	62.7	67.4	68.2	68.3	69.3	74	11.3
Rhode Island	72.5	70.7	73.7	74.2	73.8	75.9	77	6.3
South Carolina	69.0	61.3	65.6	67.6	66.8	69.6	74.9	13.6
South Dakota	67.8	39.9	64.9	65	67.7	69.6	72.2	**32.3**
Tennessee	64.6	58.6	61.8	63.5	63.3	65.2	69.3	10.7
Texas	58.0	38.5	56.5	58.4	59.5	61.7	67.9	**29.4**
Utah	68.1	54.7	64.3	66.1	67.1	68.8	71.9	**17.3**
Vermont	71.1	65.1	69	70.9	71.5	73.1	74	8.9
Virginia	67.6	58.6	64.3	66.6	66.6	69.3	73.4	14.8
Washington DC	64.8	51.4	61.2	63.9	65.5	67.1	70.8	**19.4**
West Virginia	66.3	55.4	63.3	65	64.6	66.9	73.1	**17.6**
Wisconsin	71.1	57.1	69.4	70.8	70.8	72.5	76.4	**19.2**
Wyoming	59.6	54.7	55.9	58.8	58.6	61.3	65.1	10.4

Min = Minimum; Q1 = 25th percentile; Q3 = 75th percentile; Max = Maximum.

Any CRC type includes having had at least one of the three test types: home stool blood test within 1 year, sigmoidoscopy within 5 years, or colonoscopy within 10 years.

Note: Highlighted numbers are for states with county range ≥15.0.