Estimating the Screening-Eligible Population Size, Ages 45–74, at Average Risk to Develop Colorectal Cancer in the United States AC

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ABSTRACT

Colorectal cancer is a growing burden in adults less than 50 years old. In 2018, the American Cancer Society published a guideline update recommending a reduction in the colorectal cancer screening start age for average-risk individuals from 50 to 45. Implementing these recommendations would have important implications for public health. However, the approximate number of people impacted by this change, the average-risk population ages 45–49, is not well-described in the literature. Here, we provide methodology to conservatively estimate the average-risk and screening-eligible population in the United States, including those who would be impacted by a lowered colorectal cancer screening start age. Using multiple data sources, we estimated the current average-risk population by subtracting individuals with symptomatic colorectal cancer, with a family history of colorectal cancer, and with inflammatory bowel disease and hereditary nonpolyposis colorectal cancer from the total population. Within this population, we estimated the number of screening-eligible individuals by subtracting those with previous colorectal cancer screening (45- to 49-year-old) or up to date with colorectal cancer screening (50- to 74-year-old). The total average-risk population is estimated between 102.1 and 106.5 million people, of whom 43.4–45.2 million people are eligible for colorectal cancer screening. Lowering the screening age would add roughly 19 million people to the average-risk population and increase the current number of screening-eligible individuals on immediate implementation by over 60% (from 27 to 44 million). Estimating the population size impacted by lowering the recommended colorectal cancer screening start age enables more accurate decision-making for policymakers and epidemiologists focused on cancer prevention.

Introduction

Colorectal cancer is the second deadliest malignancy in the United States, with an estimated 145,600 new cases and 51,020 deaths in 2019 (1). Although colorectal cancer is primarily diagnosed in older individuals, the incidence of colorectal cancer has been increasing in younger individuals. Since 1994, there has been a 51% increase in colorectal cancer incidence among those less than 50 years old (2). In addition, individuals less than 50 are more likely to have advanced-stage colorectal cancer at diagnosis than those over 50 (3), highlighting the potential benefit of colorectal cancer screening in this patient population.

The U.S. Preventive Services Task Force (USPSTF) published a recommendation statement in 2016 that colorectal cancer screening for eligible individuals should begin at age 50 (4). In 2018, based partly on a modeling study commissioned to expand the USPSTF analyses, the American Cancer Society (ACS) updated its colorectal cancer screening guideline and lowered the recommended screening age to 45 (2). This guideline modification has the potential to influence screening and healthcare decision-making for millions of eligible Americans. However, the number of individuals directly impacted by this potential decrease in the colorectal cancer screening start age, and a methodology to approximate that number, is not thoroughly described.

Using public databases and published literature, we established a methodology to estimate the current number of screening-eligible individuals ages 45–74 in the United States at average risk for developing colorectal cancer.

Materials and Methods

We identified the estimated number of men and women in 2019 in the United States ages 45–74 according to the U.S. Census Bureau (**Table 1**; ref. 5). We used the Surveillance Epidemiology and End Results (SEER) 2012–2016 age-adjusted annual incidence rate data from the November 2018 data submission to subtract the estimated number of individuals within each age group diagnosed with colorectal cancer prior to screening (**Table 1**; ref. 6). Notably, by subtracting all incidence colorectal cancer for individuals ages 45–49, we are conservatively assuming that the incidental cancers for all individuals would occur prior to any potential screening.

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Table 1. Estimated number of individuals ages 45–74 without diagnosed colorectal cancer.

Age group	U.S. population, estimated in 2019 (5)	CRC incidence (per 100,000), 2012–2016 (6)	Number with diagnosed CRC	Number without diagnosed CRC
45–49	20,747,135	32.3	6,701	20,740,434
50–54	20,884,564	60.5	12,635	20,871,929
55–59	21,940,985	67.2	14,744	21,926,241
60–64	20,331,651	89.0	18,095	20,313,556
65–69	17,086,893	119.9	20,487	17,066,406
70–74	13,405,423	151.7	20,336	13,385,087

Note: Estimates were derived from U.S. Census Bureau and SEER incidence data.
Abbreviation: CRC, colorectal cancer.

To identify the number of individuals with a family history of colorectal cancer, we reviewed the population-based studies included in the meta-analysis by Henrikson and colleagues, published in 2015 (7). We used two estimates for family history prevalence due to the heterogeneity of outcomes reported in the meta-analysis. For our smaller estimate, we used a conservative definition of family history ("one or more first-degree relatives with colorectal cancer") and identified studies with prevalence values from populations that met our definition of family history (**Table 2**). We calculated an overall prevalence by weighing the prevalence values from each study based on population size (we removed one study from consideration, Taylor and colleagues; ref. 8, due to its outcomes being restricted to a single U. S. state and its disproportionate influence on a weighted prevalence calculation). For our larger estimate, we used the commonly cited value of 10%, which also corresponds to the upper bound of the prevalence estimate from the summary tables in Henrikson and colleagues (7). Using these two percentages, we subtracted the estimated number of people with colorectal cancer family history from our population.

Next, we estimated the total proportion of individuals with hereditary cancer syndromes associated with colorectal cancer: inflammatory bowel disease (IBD), hereditary nonpolyposis colorectal cancer (HNPCC or Lynch Syndrome), and familial adenomatous polyposis (FAP). We assumed the population-wide prevalence for these syndromes was representative of the 45- to 74-year-old population. For IBD, we used the combined estimated prevalence of ulcerative colitis and Crohn disease (0.5%) in the United States, made in 2016 (9). For HNPCC, we used 0.25%, which we extrapolated from the ACS's Cancer

Table 2. Studies selected for estimating prevalence of colorectal cancer family history.

Reference	Data source	*n*	Average age (range)	% Female	Description of family history category	Prevalence	Weight
Scheuner and colleagues, 2010 (15)	California Health Interview Survey	33,187	39.3	50*	Either one FDR or two SDRs, dx age > 50 or one SDR dx age <50 with CRC and 1+ SDR dx age >50 with endometrial cancer	4.2%	0.044
					Either 1+ FDR dx age < 50 or 2+ ADR or hereditary syndrome	1.1%	
Pinsky and colleagues, 2003 (16)	Prostate, Lung, Colorectal, and Ovarian (PLCO) Cancer Screening Trial	149,332	NR (55–74)	51	1 FDR	9.4%	0.196
					2+ FDR	0.7%	
Sandhu and colleagues, 2001 (17)	EPIC-Norfolk (UK)	30,353	59.1	55	1+ FDR with CRC	6.8%	0.040
Poole and colleagues, 1999 (18)	Cancer Prevention Study-1	429,483	51	100	1+ FDR with CRC	3.7%	0.564
Fuchs and colleagues, 1994 (19)	Nurses' Health Study	87,031	49.1	100	1+ FDR with CRC	9.4%	0.114
	Health Professionals Follow-up Study	32,085	51.5	0	1+ FDR with CRC	10.0%	0.042

Note: Studies originally included in meta-analysis by Henrikson and colleagues (7).
Abbreviations: ADR, any-degree relative; CRC, colorectal cancer; dx, diagnosed; FDR, first-degree relative; NR, not reported; SDR, second-degree relative.
*Weighted.

Facts and Figures 2017–2019 (800,000 individuals divided by an approximate U.S. population of 320,000,000; ref. 10). For FAP, we assumed that the population was negligible because most individuals with FAP would be diagnosed with colorectal cancer before age 45 (11) and therefore would not be included in this population.

Finally, we determined the screening-eligible population by subtracting the estimated number of people who already received colorectal cancer screening (both invasive and noninvasive modalities). Individuals ages 45–49 were considered separately because they are not currently recommended for colorectal cancer screening and therefore have different screening eligibility rates than individuals ages 50–74. For individuals ages 45–49, the estimated percentage of previously screened individuals is 7.2%, according to 2019 National Health Interview Survey data (12). For individuals ages 50–74, the estimated percentage of individuals up-to-date with colorectal cancer screening is 68.8%, according to 2018 data from the Behavioral Risk Factor Surveillance System (13).

Results

The complete workflow and population estimate for each analysis subgroup is described in **Fig. 1**. We removed individuals diagnosed with colorectal cancer, without a family history of colorectal cancer, and with hereditary cancer syndromes associated with colorectal cancer from the total estimated population of the United States. We estimate the total average-risk population to be between 102.1–106.5 million people (18.5–19.3 million ages 45–49 and 83.6–87.2 million ages 50–74). After removing individuals who have undergone colorectal cancer screening, we estimate the total average-risk, screening-eligible population

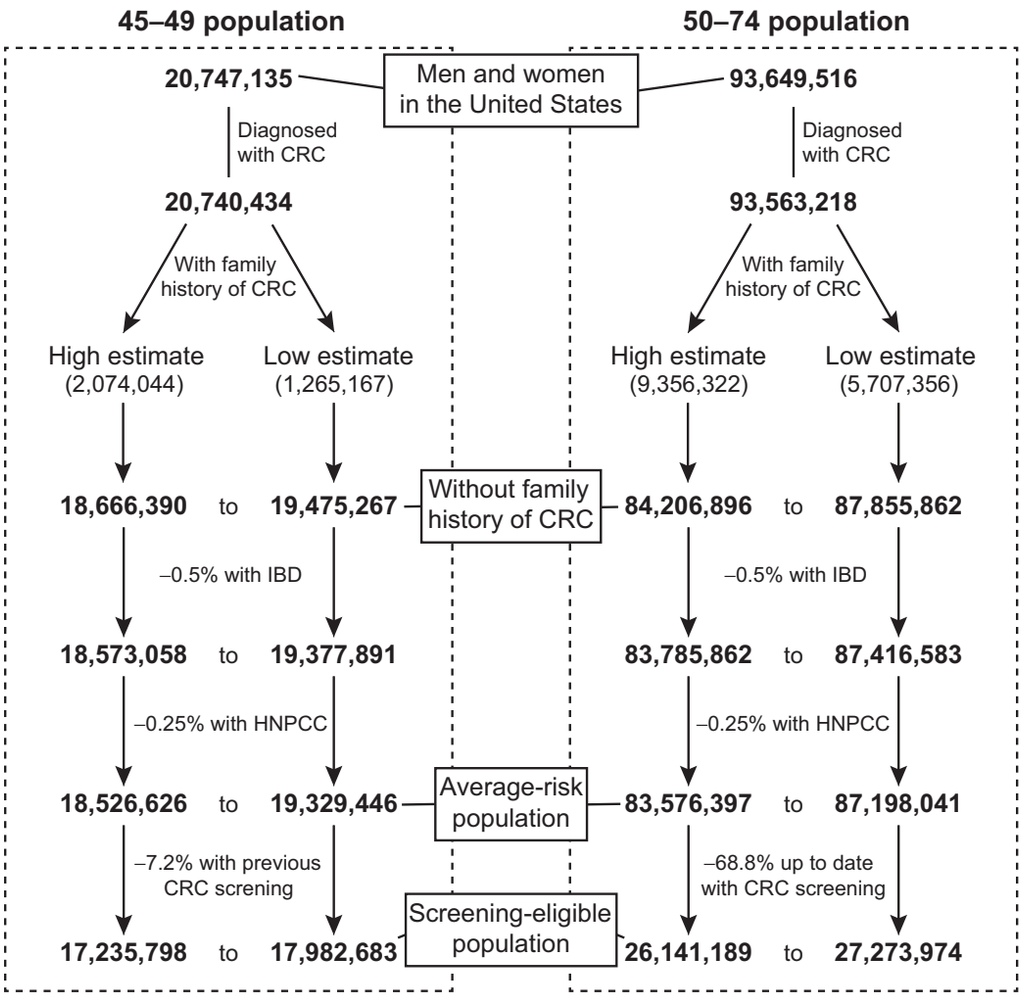

Figure 1.

Workflow to estimate the population of screening-eligible individuals in the United States, ages 45–74, at average risk for developing colorectal cancer (CRC). Individuals ages 45–49 are considered separately because they are not recommended for colorectal cancer screening under current guidelines and therefore have different colorectal cancer screening rates than individuals ages 50–74.

to be between 43.4 and 45.2 million people (17.2–18.0 million ages 45–49 and 26.1–27.3 million ages 50–74).

Discussion

Lowering the recommended colorectal cancer screening start age to 45 will substantially increase the percentage of individuals who would be newly eligible for screening. By implementing the lowered screening age, we estimate that an additional 19 million people would be added to the average-risk population, or approximately 21.2%–23.1% of the current population. Among average-risk individuals, upon immediate adoption of a lowered colorectal cancer screening age, the screening-eligible population would increase by over 60%, from roughly 27 to 44 million people. This increase could have significant consequences for colorectal cancer prevention and early detection, given the increased incidence of colorectal cancer among younger individuals (2).

Overall, this analysis provides a comprehensive estimate of the average-risk population eligible for colorectal cancer screening in the United States, including whether the recommended start age is lowered to 45 years. One limitation of our analysis is overlapping populations probably exist among these groups, for example, individuals having received colorectal cancer screening because they have hereditary cancer syndromes. One study found that 20% of individuals under age 50 who had received colonoscopies reported that the reason was colorectal cancer screening (14). This percentage could be similar across screening modalities. In addition, our estimate does not incorporate subgroup analyses based on gender, race/ethnicity, or socioeconomic status, although notably, the ACS-recommended screening start age does not discriminate based on these characteristics. Finally, we anticipate that the percentage of individuals with hereditary colorectal cancer syndromes will increase over time as new acquired genetic abnormalities are discovered.

Ultimately, this estimate is important for policy makers and healthcare systems to better understand the population benefitting from changing colorectal cancer screening guidelines to improve cancer prevention and early detection.

Disclosure of Potential Conflicts of Interest

A. Piscitello and D.K. Edwards V reports receiving personal fees from Exact Sciences during the conduct of the study. No potential conflicts of interest were disclosed.

Authors' Contributions

Conception and design: A. Piscitello, D.K. Edward V
Development of methodology: A. Piscitello, D.K. Edwards V
Acquisition of data (provided animals, acquired and managed patients, provided facilities, etc.): A. Piscitello, D.K. Edwards V
Analysis and interpretation of data (e.g., statistical analysis, biostatistics, computational analysis): A. Piscitello, D.K. Edwards V
Writing, review, and/or revision of the manuscript: A. Piscitello, D.K. Edwards V
Administrative, technical, or material support (i.e., reporting or organizing data, constructing databases): A. Piscitello, D.K. Edwards V
Study supervision: A. Piscitello, D.K. Edwards V

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