Estimating health benefits and cost-savings for achieving the Healthy People 2020 objective of reducing invasive colorectal cancer[⋆]

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Abstract

This study aims to quantify the aggregate potential life-years (LYs) saved and healthcare cost-savings if the Healthy People 2020 objective were met to reduce invasive colorectal cancer (CRC) incidence by 15%. We identified patients ($n = 886,380$) diagnosed with invasive CRC between 2001 and 2011 from a nationally representative cancer dataset. We stratified these patients by sex, race/ethnicity, and age. Using these data and data from the 2001–2011 U.S. life tables, we estimated a survival function for each CRC group and the corresponding reference group and computed per-person LYs saved. We estimated per-person annual healthcare cost-savings using the 2008–2012 Medical Expenditure Panel Survey. We calculated aggregate LYs saved and cost-savings by multiplying the reduced number of CRC patients by the per-person LYs saved and lifetime healthcare cost-savings, respectively. We estimated an aggregate of 84,569 and 64,924 LYs saved for men and women, respectively, accounting for healthcare cost-savings of $329.3 and $294.2 million (in 2013$), respectively. Per person, we estimated 6.3 potential LYs saved related to those who developed CRC for both men and women, and healthcare cost-savings of $24,000 for men and $28,000 for women. Non-Hispanic whites and those aged 60–64 had the highest aggregate potential LYs saved and cost-savings. Achieving the HP2020 objective of reducing invasive CRC incidence by 15% by year 2020 would potentially save nearly 150,000 life-years and $624 million on healthcare costs.

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1. Introduction

Of cancers that affect both men and women, colorectal cancer (CRC) is the second leading cause of cancer-related deaths in the United States and the third most common cancer in men and in women (CDC, 2017a,b). The Healthy People 2020 (HP2020) agenda for improving the health of all Americans established the following objectives for colorectal cancer: 1) reduce the CRC death rate, 2) reduce the rate of invasive CRC, and 3) increase the proportion of adults who receive CRC screening based on current recommendations (HP2020, 2014).

A recent study from the Centers for Disease Control and Prevention (CDC) showed that while overall CRC test use increased from 2000 to 2015, the nation still had not reached the HP2020 target for increasing CRC screening (White et al., 2017). Weir and colleagues used mortality data from the CDC's National Vital Statistics System (NVSS, 2016) to predict a reduction of 22.5% in CRC death rate from 2007 to 2020 and that the HP2020 target for reducing the CRC death rate would be met in 2013 (Weir et al., 2015). The target for the United States was met in 2014 (HP2020HP2014) and when examined by state, 30 states had achieved the HP2020 target to reduce invasive CRC incidence rates (Henley et al., 2017).

Given the mixed progress in meeting HP2020 CRC objectives for increasing CRC screening and reducing CRC death rates, we aim to focus on the HP2020 CRC objective of reducing the invasive CRC incidence rate from a baseline (year 2007) of 46.9/100,000 population to a target of 39.9/100,000 population in 2020 (HP2020HP2014), representing a 15% reduction over 10 years. We estimate the potential life-years (LYs) saved (health benefit) and lifetime healthcare cost-savings if this objective of reducing 15% of the invasive CRC incidence rate in 2007 were met by 2020. The purpose of this study is to provide federal, state, and local health policy-makers with potential quantifiable benefits that could occur if effective evidence-based interventions are implemented to achieve this objective. To our knowledge, this study is the first to quantify the health and economic benefits of achieving the HP2020 CRC objective for reducing invasive CRC incidence rates.

2. Methods

2.1. Dataset for the estimation of the survival functions for CRC patients

We used the United States Cancer Statistics (USCS) data from the CDC's National Program of Cancer Registries (NPCR) and the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) program, which together cover the cancer incidence for the entire U.S. population (CDC, 2016a,b; NCI, 2014). Both NPCR and SEER registries collect detailed patient information, including sex, race/ethnicity, year of diagnosis, age of diagnosis, cancer site, stage, survival months, histology, and vital status (CDC, 2016a,b; NCI, 2014). In 2014, the USCS provided data on survival for 62.8% of the U.S. population

(32 central cancer registries). From USCS, we identified a total of 886,380 patients who had been diagnosed with primary invasive CRC between 2001 and 2011, according to the International Classification of Disease for Oncology, 3rd Edition (ICD-O-3) site codes of C180–189, C209, and C260, with exclusion of patients with mesothelioma (histology codes of 9050–9055), kaposi sarcoma (9140), and lymphomas and leukemia (9590–9992). The CRC patients were followed through December 31, 2012 with a follow-up between 12 and 144 months. Patients who had not died on this date were censored. The CRC patients were stratified by sex, race/ethnicity, and age.

2.2. Per-person potential LYs saved

For each group of the CRC patients, we used the Kaplan-Meier method to estimate a survival function for the 144 months following diagnosis (the longest follow-up with available data). We then extrapolated the survival function up to 600 months, using a semi-parametric method (Hwang and Wang, 1999) (Fig. 1). 600 months was chosen, because these CRC patients' survival probability approximates to zero at 600 months. The technical details for the extrapolation process has been described elsewhere (Chu et al., 2008; Fang et al., 2007; Hung et al., 2014; Liu et al., 2013). Briefly, this method used the data from the 2001–2011 U.S. life tables of the general population (CDC, 2015) as a reference population. Using the same stratification as the stratification in CRC patients, we generated a survival function for each reference group corresponding to each group of the CRC patients. For each CRC-reference group, we fitted a linear regression to the logit transformed survival ratios (survival probabilities of the CRC group to those of the corresponding reference group) for the last 24 months of the 144 months of follow-up. Assuming a constant excess hazard (Andersson et al., 2013; Fang et al., 2007), we extrapolated the logit transformed survival ratios to 600 months and thus the survival function for each CRC group beyond the 144 months to 600 months.

Based on the estimated survival functions for the CRC and the reference groups, we derived life expectancies (LEs) for each CRC group and the corresponding reference group. We then computed per-person potential LYs saved by subtracting LE for each reference group from that for the corresponding CRC group (Fig. 1).

2.3. Dataset for the estimation of the annual healthcare costs associated with CRC

We used data from the Medical Expenditure Panel Survey (MEPS) Household Component to estimate costs associated with CRC. The MEPS is a nationally representative survey that estimates healthcare use, expenditures, sources of payment, and insurance coverage for the U.S. civilian non-institutionalized population (AHRQ, 2015a). We pooled data from 2008 to 2012, which comprised 177,054 people, including 587 individuals who reported that they were ever diagnosed with CRC. Annual healthcare expenditures in the MEPS are defined by the sum of the total annual healthcare costs paid via any type of payment (out-of-pocket, private insurance, Medicare, Medicaid, and other sources) for any service (ambulatory care, inpatient care, prescription medications, home health care, nursing home care, and other services) in a year (AHRQ, 2015a). We adjusted all costs to the 2013 price level using the Personal Health Care Expenditure Price Index (AHQR, 2015a,b).

2.4. Per-person annual healthcare cost associated with CRC

We used a two-part model to estimate per-person annual healthcare cost associated with CRC, because the distribution of the cost data was right-skewed with 22% of the individuals with zero expenditure (Manning and Mullahy, 2001). In the first part, we used a logit model to predict the probability of any healthcare utilization; in the second part, we estimated utilization among those with positive expenditures using a generalized linear model with log-link and gamma-variance function. The covariates in this two-part model included CRC diagnosis (yes/no), sex, race/ethnicity, age, education, marital status, number of comorbid conditions, health insurance, and U.S. Census region. Based on the results, we predicted the average per-person annual healthcare costs associated with CRC for each of the sex, racial/ethnic, and age groups.

2.5. Per-person lifetime healthcare cost-savings

For each group, we defined per-person lifetime cost-savings as the total cost saved, had a CRC patient not developed CRC. We used the following equation to calculate the mean per-person lifetime cost-savings (E).

$$E = \int_0^\infty S(t) C(t) dt$$

where t is time following CRC diagnosis, $S(t)$ is the survival function for CRC patients (previously derived in Section 2.2), and $C(t)$ is a smoothed function of healthcare cost associated with CRC in present value, based on the predicted annual healthcare costs associated with CRC (Section 2.4). Present values were calculated using an annual rate of 3% (Gold et al., 1996) (Fig. 2).

2.6. Aggregate potential LYs saved and the corresponding healthcare cost-savings

We assumed that the HP2020 objective of a 15% reduction in the 2007 CRC incidence rate in 2020 is the same for each group. We computed the expected reduction in the number of CRC patients for each group by multiplying the 15% reduction in age-adjusted incidence rate in 2007 by the projected 2020 population for each group (USCB, 2012).

We calculated the aggregate potential LYs saved for each group by multiplying the expected reduction in the number of CRC patients by the potential per-person LYs saved. We calculated the aggregate healthcare cost-savings for each group by multiplying the expected reduction in the number of CRC patients by the estimated per-person lifetime cost-savings.

2.7. Statistical analysis

We adjusted for the complex sampling design in the MEPS following the analytic guidelines (AHRQ, 2014). We examined differences in per-person potential LYs saved and lifetime cost-savings between groups using a two-sided Z-test at the 0.05 level.

We used SAS 9.3 (SAS Institute Inc., Cary, NC) and STATA 13.1 (StataCorp LP, College Station, TX) for analyses. We estimated LE, per-person potential LYs saved, and per-person

lifetime cost-savings using the Integration of Survival with Quality of Life (iSQoL) statistical package (http://www.stat.sinica.edu.tw/isqol/).

All of the results are presented by men and women; non-Hispanic whites (NHW), non-Hispanic blacks (NHB), and Hispanics; and age groups 50–54, 55–59, 60–64, 65–69, 70–74, 75–79 and 80 years. The latter two age groups are not reported in the Results section (but are included in the tables), because regular CRC screening is not recommended for persons aged 75 years. We do not present groups whose incidence rates in 2007 were lower than the HP2020 target objective of 39.9/100,000 population (HP2020, 2014): American Indians or Alaska Natives, Asian/Pacific Islanders, and people aged < 50 years.

3. Results

3.1. Population characteristics

Table 1 presents the characteristics of CRC patients from NPCR/ SEER and the MEPS sample, stratified by sex, race/ethnicity, and age. For the 886,380 patients diagnosed with CRC between 2001 and 2011 (Table 1, upper panel), mean age at diagnosis was 66.7 years for men and 69.3 years for women; 69.2 years for NHW, 64.3 years for NHB, and 63.3 years for Hispanics. During follow-up, 402,501 (45.4%) patients died. Mean survival for patients who died was 24.5 months for men and 23.8 months for women; 24.6 months for NHW, 21.5 months for NHB, and 23.4 months for Hispanics. Mean survival was 26.0, 25.3, 25.0, 26.1, and 26.1 months for age group 50–54, 55–59, 60–64, 65–69, and 70–74, for patients who died during follow-up.

For the general population estimated from the 2008–2012 MEPS (Table 1, lower panel), mean age at survey of individuals with CRC was 70.0 years for men and 71.2 years for women; 70.8 years for NHW, 63.0 years for NHB, and 64.0 years for Hispanics. Mean annual healthcare costs were higher for men ($17,304) than women ($13,483) and for NHW ($17,079) than Hispanics ($9551) and lowest for NHB ($7026). For age groups, mean annual healthcare costs ranged from $10,705 (age 50–54) to $21,042 (age 55–59).

3.2. Expected reduction in CRC patients, potential per-person LYs saved and aggregate potential LYs saved in the population

If the HP2020 objective of reducing invasive CRC incidence rate by 15% were met, we estimated a reduction of 13,473 cases in men and 10,348 cases in women between 2007 and 2020 (Table 2); by race/ ethnicity, we estimated a reduction of 13,872 cases in NHW, 3515 cases in NHB, and 3894 cases in Hispanics.

For each cancer averted, the estimated potential LYs saved for those who developed CRC was 6.3 years for both men and women; 6.1 years for NHW, 7.8 years for NHB, and 8.6 years for Hispanics ($p < 0.05$). The estimated potential LYs saved ranged from 9.3 years for adults aged 50–54 years to 4.7 years for adults aged 70–74 years. The estimated aggregate potential LYs saved was 84,569 years for men and 64,924 years for women, i.e., ~150,000 years for the entire population; 84,002 years for NHW, 27,260 years for NHB, and 33,380 years for Hispanics (Table 2). The aggregate potential LYs saved ranged from 16,292 years for adults aged 50–54 years to 25,482 years for adults aged 60–64 years.

3.3. Per-person lifetime healthcare cost-savings and aggregate healthcare cost-saving associated with CRC

The estimated lifetime cost-savings for each CRC case prevented were $24,000 (standard error, SE = $24) for men and $28,000 (SE = $30) for women ($p < 0.05$) (Table 3); $27,000 for NHW (SE = $23), $23,000 (SE = $42) for NHB, and $26,000 (SE = $47) for Hispanics ($p < 0.05$). The estimated per-person lifetime cost-savings ranged from $28,000 for adults aged 70–74 years to $46,000 for adults aged 50–54 years. Aggregate healthcare cost-savings were $329.3 million for men and $294.2 million for women, i.e., ~$624 million for the entire population; $371.2 million for NHW, $80.8 million for NHB, and $102.5 million for Hispanics. Aggregate savings ranged from $79.8 million for age group 50–54 to $143.9 million for age group 60–64.

4. Discussion

This study provides estimates of potential LYs saved and lifetime cost-savings at per-person and aggregate levels, if the HP2020 objective for a 15% reduction in invasive CRC incidence rates by year 2020 were met. We found that (1) per-person LYs saved was similar for men and women, but per-person lifetime cost-savings were higher for women than men; the aggregate LYs saved and aggregate cost-savings were larger for men than women; (2) per-person LYs saved was the highest for Hispanics, followed by NHB and NHW, while per-person lifetime cost-savings, aggregate LYs saved, and aggregate cost-savings were the highest for NHW, followed by Hispanics and NHB; (3) both per-person LYs saved and lifetime cost-savings decreased with age, while adults aged 60–64 years had the highest aggregate potential LY saved and aggregate lifetime costs-savings; and (4) overall achieving this objective would save ~150,000 LYs and $624 million on healthcare costs.

We note that the inconsistency between the per-person and the aggregate estimates when comparing between groups can be attributed to the expected reduction in the number of CRC cases for each group, resulting from the reduction in the incidence rate in 2007 and the projected 2020 population size for each group. When comparing LYs saved between men and women, the inconsistency (i.e., per-person potential LYs saved: men ≈ women, but aggregate potential LYs saved: men > women) results from the much higher incidence rate for men than women, dominating the effect of the larger size of the projected 2020 female population, and therefore a 15% reduction in the baseline incidence rate resulting in a much higher expected reduction in the number of CRC cases for men. When comparing potential LYs saved between racial/ethnic groups, the inconsistency (i.e., per-person potential LYs saved: Hispanic > NHB > NHW, while aggregate potential LYs saved: NHW > Hispanics > NHB) results from a much larger size of the projected 2020 NHW population than the higher incidence rate for NHB. The same rationale can be applied to the comparison between age groups and extended to explain the inconsistency in the per-person and the aggregate healthcare cost-savings between groups.

Similar to our study, Liu and colleagues found, using SEER registry data, that the expected years of life lost for CRC patients in comparison with the reference population was 6.5 years. (Liu et al., 2013); in our study, the estimated potential LYs saved was 6.3 years for both men and women, if the incidence rates of CRC were reduced by 15%. Using the linked

SEER-Medicare dataset, 1996–2002, Lang et al. (2009) showed that excess CRC-related healthcare costs (defined as the difference in costs between CRC and the matched comparison patients, similar to our study) were $28,626 (in 2006$, $33,079 in 2013$) for patients aged 66 years (Lang et al., 2009), compared with $32,000 (age 65–69) and $28,000 (age 70–74) in our study. The higher cost in Lang et al. could potentially be attributed to different data sources and different methods for estimating cost in SEER-Medicare and MEPS, and different methods computing lifetime costs.

As reported in this paper, achieving the HP2020 objective of reducing invasive CRC incidence by 15% by year 2020 would potentially save ~150,000 life-years and $624 million on healthcare costs. To achieve this objective may require implementing evidence-based single-or multi-component interventions recommended by the Community Preventive Services Task Force (Sabatino et al., 2012). These interventions such as client reminders, client incentives, one-on-one education, reducing out-of-pocket costs, reducing structural barriers, provider assessment and feedback, and provider incentive, have been found to be effective in increasing community demand, enhancing community access, and increasing provider delivery of recommended CRC screening services. The potential health benefits and substantial cost-savings reported in this paper can further encourage on-going efforts around implementing evidence-based interventions for CRC prevention and awareness that could aid in achieving the HP2020, or even HP2030 objective.

Furthermore, our results show that after reducing invasive CRC incidence rates by 15% for each group from 2007 to 2020, the aggregate potential LYs saved and cost-savings were highest among male, NHW, and age 60–64 population. These results can help inform adjustments to objectives to eliminate disparities between groups. For example, among the racial/ethnic groups, NHB had the highest baseline CRC incidence rate, followed by NHW and Hispanics (HP2020, 2014). Based on our results, a CRC prevention and control initiative targeting an additional 3–4% reduction (to the 15% reduction) for NHB would eliminate the gap in the aggregate LYs saved between NHB and Hispanics, and an additional 31–32% reduction would eliminate the gap between NHB and NHW.

CRC prevention and control initiatives include promoting healthy weight, physical activity, smoking cessation, reducing consumption of alcohol and red and processed meats, and increasing vitamin D intake (Moukayed and Grant, 2013; Mohr et al., 2015). These prevention activities are part of the CDC's comprehensive cancer control program efforts to prevent CRC before it ever occurs (CDC, 2016a,b). CDC has also developed and implemented the Colorectal Cancer Control Program, which funds grantees in 23 states, 6 universities and one tribe to promote population-wide CRC screening through the use of recommended evidence-based interventions described earlier. The program also strives to improve adherence to CRC screening and to assure timely and appropriate clinical preventive services and treatment (Henley et al., 2017; CDC, 2016a,b). Moreover, CDC has a long-running multimedia, multi-pronged national campaign to educate people about their CRC risks and to encourage age-eligible population to be screened (CDC, 2017a,b; Ekwueme et al., 2014). It is our belief that these CDC efforts will contribute to achieving the HP2020 CRC objective and the findings reported in this paper serve as approximations of the potential health benefits and cost-savings from these efforts.

Our study has several strengths. First, stratified by sex, race/ethnicity, and age, our results provide data for cost-effectiveness analysis or budget impact analysis to evaluate CRC prevention programs at the subpopulation level. Second, the estimation of the survival curves is robust because the extrapolation beyond the follow-up is based on a validated method (Hwang and Wang, 1999). Last, our costs estimates were obtained from a nationally representative dataset, which covers a wide range of medical services and payers and includes survey participants at all ages.

Our study also has several limitations. As previously stated, we did not present groups whose 2007 incidence rates were lower than the HP2020 target objective of 39.9/100,000 population. Such groups include American Indians or Alaska Natives, Asian/Pacific Islanders, and people aged < 50 years. However, some of the highest CRC incidence rates in the U.S. occur among American Indians or Alaska Natives populations in Alaska and the Northern and Southern Plains (Perdue et al., 2014). This study did not estimate the benefit of reducing CRC incidence in these populations. Our survival functions were estimated based on the existing data from 2001 to 2011. If recently developed treatment regimen which significantly improves survival outcomes for CRC patients is used as standard of care after 2011, our estimates of LYs saved may be overestimated. However, lifetime healthcare cost-savings can be either underestimated or overestimated, depending on how costly the new technology or treatment regimen will be. We assumed that annual cost associated with CRC was an average and therefore constant throughout their lifespan. However, CRC patients usually incur increased costs at later stages, which was not captured in our analyses. Nonetheless, this impact can be minimized by using average annual cost to compute the lifetime costs. Moreover, as aforementioned, our aggregate estimates are mainly driven by the assumption on a 15% reduction in the baseline CRC incidence rate for every group, which needs to be noted as a caveat when interpreting the aggregate estimates. Nonetheless, the percentage reduction can be changed based on the target aggregate LYs saved and lifetime cost-savings to implement CRC prevention and control programs and activities. Our analysis was also unable to capture the additional benefits of screening on early detection of CRC after 2011. Thus, we may have underestimated the health benefits and cost-savings. Last, we used relative survival rather than cause-specific survival to estimate life expectancy to avoid the potential bias from misclassification of CRC-specific cause of death and competing risks (Janssen-Heijnen et al., 2010; Nelson, 2017; Sarfati et al., 2010). However, we also recognize that using relative survival has its own bias, e.g., requiring detailed life tables of the comparison group (Hu et al., 2013), which does not apply to our study.

5. Conclusion

Reducing CRC incidence by 15% from 2007 to 2020 could have significant benefits for the nation in terms of potential LYs saved (~150,000 years) and lifetime healthcare cost-savings (~$624 million). Our results provide quantitative measures of the health and financial benefits of meeting the HP2020 objective for CRC incidence. This study framework can be used to assess future progress in improving health and economic outcomes of CRC.
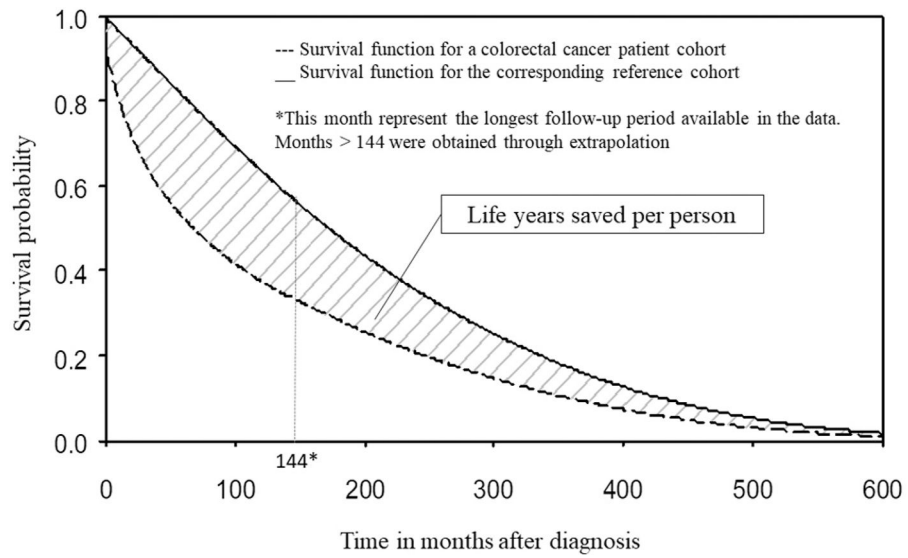
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Fig. 1.

A graphical illustration of per-person potential life years saved.

Dashed curve: survival function for a colorectal cancer (CRC) patient cohort.

Solid curve: survival function for the corresponding reference group.

Shaded area: the difference in life expectancies between a CRC group and the corresponding reference group.
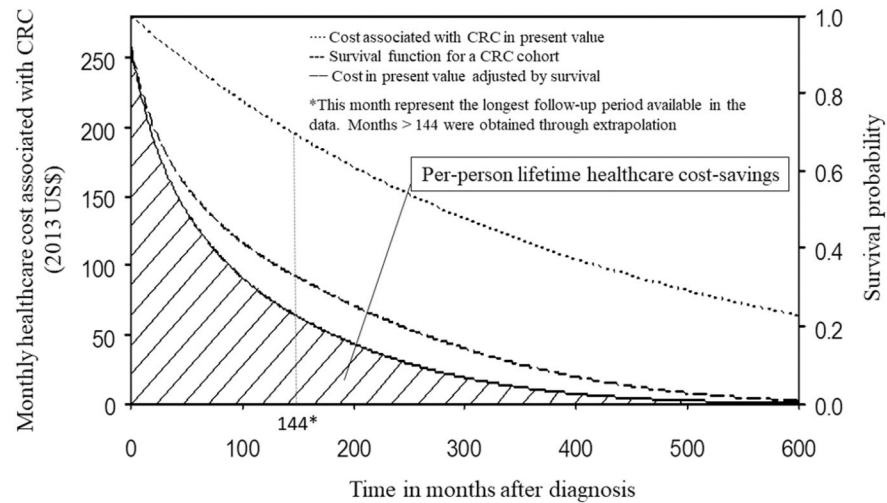
Fig. 2.

A graphical illustration of per-person lifetime healthcare cost-savings.

Dotted curve: smoothed function of healthcare cost associated with colorectal cancer (CRC) in present value.

Dashed curve: survival function for a CRC group.

Solid curve: expected cost in present value.

Shaded area: per-person lifetime health care cost savings.

Table 1

Characteristics of the CRC patients from the National Program of Cancer Registries (NPCR) and Surveillance, Epidemiology, and End Results (SEER) program, 2001–2011 with follow-up to 2012 and data from the Medical Expenditure Panel Survey (MEPS), 2008–2012.

	NPCR + SEER data				MEPS data					
	CRC size	Mean age at diagnosis (95% CI)	Mean survival months for people who died during 2001–2012 (95% CI)	Number of deaths during follow-up	CRC		Non-CRC		Mean age at survey for CRC[a] (95% CI)	Mean annual healthcare costs for CRC[a] (95% CI)
					n	N	n	N		
Total	886,380	68.0 (68.0–68.0)	24.2 (24.1–24.2)	402,501	587	1,296,500	176,467	307,548,722	70.6 (69.2–72.1)	15,235 (13,578–16,892)
Sex										
Male	455,055	66.7 (66.7–66.8)	24.5 (24.4–24.6)	208,743	273	594,465	84,596	150,759,522	70.0 (68.1–72.0)	17,304 (15,326–19,282)
Female	431,325	69.3 (69.3–69.4)	23.8 (23.7–23.9)	193,758	314	702,035	91,871	156,789,200	71.2 (69.9–72.4)	13,483 (11,046–15,920)
Race/ethnicity										
Non-Hispanic White	677,169	69.2 (69.2–69.3)	24.6 (24.5–24.7)	314,306	173	280,504	42,203	69,041,361	70.8 (69.2–72.4)	17,079 (13,416–20,743)
Non-Hispanic Black	98,792	64.3 (64.2–64.4)	21.5 (21.3–21.8)	46,736	44	46,082	16,916	18,850,692	63.0 (60.9–65.0)	7026 (3767–10,284)
Hispanic	67,062	63.3 (63.2–63.4)	23.4 (23.1–23.7)	26,772	55	68,478	51,597	50,641,478	64.0[b]	9,551[b]
Age group (years)										
50–54	73,108		26.0 (25.7–26.3)	20,485	42	105,901	11,542	22,784,168		10,705 (4605–16,804)
55–59	83,742		25.3 (25.0–25.6)	26,776	36	70,579	10,039	19,477,669		21,042[b]
60–64	95,042		25.0 (24.8–25.3)	33,554	75	151,497	8197	17,033,558		18,668 (7119–30,216)
65–69	107,555		26.1 (25.8–26.3)	41,314	79	134,669	6226	12,494,032		13,194 (12,460–13,928)
70–74	114,711		26.1 (25.9–26.3)	52,251	81	206,437	4400	9,213,053		13,162 (12,309–14,015)
75–79	120,573		25.7 (25.5–25.9)	64,553	77	170,221	3487	7,447,965		12,017 (11,526–12,058)
80+	203,580		21.3 (21.1–21.5)	68,520	157	397,223	4862	10,897,464		16,497 (13,583–19,411)

CRC, colorectal cancer; CI: confidence interval; n, sample size; N, estimated population size.

[a] Population estimates.

[b] We did not calculate the 95% CIs of these point estimates because the sample size were too small.

Table 2

Expected reduction in patients with invasive colorectal cancer by 15%, per-person potential life-years (LYs) saved and aggregate potential LYs saved in the population.

	Incidence rate in 2007 (per 100,000 population)[a][g]	Incidence rate in 2020 (per 100,000 population)[b]	Projected population in 2020[c]	Expected reduction in the number of CRC[d]	Life expectancy for CRC patients (SE)	Life expectancy for reference population (SE)	Per-person LYs saved (SE)[e]	Aggregate LYs saved[f]
Total	46.90	39.90	333,895,553	23,821	–	–	–	149,493
Sex								
Male	54.50	46.33	164,811,926	13,473	10.45 (0.01)	16.73 (0.01)	6.28 (0.01)	84,569
Female	40.80	34.68	169,083,627	10,348	11.13 (0.01)	17.40 (0.01)	6.27 (0.01)	64,924
Race/ethnicity *								
Non-Hispanic White	46.40	39.44	199,312,742	13,872	10.36 (0.01)	16.41 (0.01)	6.06 (0.01)	84,002
Non-Hispanic Black	56.10	47.69	41,775,711	3515	10.55 (0.02)	18.31 (0.03)	7.75 (0.02)	27,260
Hispanic	40.70	34.60	63,784,157	3894	13.34 (0.02)	21.91 (0.03)	8.57 (0.03)	33,380
Age group (years) *								
50–54	57.00	48.45	20,466,535	1750	19.44 (0.03)	28.75 (0.03)	9.31 (0.02)	16,292
55–59	76.70	65.20	21,747,043	2502	16.06 (0.03)	24.45 (0.02)	8.39 (0.02)	20,989
60–64	107.40	91.29	21,016,992	3386	12.92 (0.02)	20.45 (0.03)	7.53 (0.02)	25,482
65–69	162.50	138.13	18,052,082	4400	10.93 (0.02)	16.68 (0.03)	5.75 (0.02)	25,307
70–74	211.90	180.12	14,744,309	4686	8.51 (0.02)	13.17 (0.02)	4.67 (0.02)	21,864
75–79	264.50	224.83	10,009,961	3971	6.49 (0.01)	10.16 (0.02)	3.67 (0.02)	14,580
80+	333.30	283.31	13,162,518	6581	3.94 (0.01)	6.30 (0.01)	2.36 (0.01)	15,528

SE, standard error.

[a]Source: Healthy People 2020, 2014.

[b]Incidence rate in 2007 × (1–0.15).

[c]Source: United States Census Bureau (USCB), 2012. National Population Projections.

[d]Expected reduction in the number of CRC patients = Difference in incidence rates between 2007 and 2020 × projected 2020 population.

[e]LYs saved = life expectancy of the reference population – life expectancy of CRC patients.

[f]Aggregate LYs saved was calculated by multiplying the estimated reduction in the number of CRC patients with per-person LYs saved.

gIncidence rate for each age group is not age adjusted.

*
$p < 0.05$ for statistical tests comparing per-person LYs saved between groups.

Table 3

Per-person lifetime cost-savings and aggregate cost-savings if the Healthy People (HP) 2020 target of reducing invasive colorectal cancer (CRC) by 15% for each group were achieved.[a]

	Per-person lifetime cost- savings[b] (2013$) (SE)	Aggregate lifetime cost-savings[c] (million, 2013$)
Total	–	623.5
Sex [*]		
Male	24,000 (24)	329.3
Female	28,000 (30)	294.2
Race/ethnicity [*]		
Non-Hispanic White	27,000 (23)	371.1
Non-Hispanic Black	23,000 (42)	80.8
Hispanic	26,000 (47)	102.5
Age group (years) [*]		
50–54	46,000 (68)	79.8
55–59	45,000 (70)	111.5
60–64	43,000 (68)	143.9
65–69	32,000 (59)	142.7
70–74	28,000 (53)	129.7
75–79	22,000 (53)	88.9
80+	15,000 (30)	100.0

SE, standard error.

[a] All healthcare costs were adjusted to 2013 dollars using the Personal Health Care Expenditure Price Index. CRC status, age, sex, race, education, marital status, number of comorbid conditions, health insurance, and census region were controlled for in the two-part model.

[b] See Section 2.5 for the calculation of per-person lifetime cost-savings.

[c] Aggregate cost-savings were calculated by multiplying the estimated reduction in the number of CRC patients with per-person lifetime cost-savings.

[*] $p < 0.05$ comparing statistically significant difference in per-person lifetime cost savings among sex, race/ethnicities and age groups.