The Aggregate Value of Existing Cancer Screenings in the US

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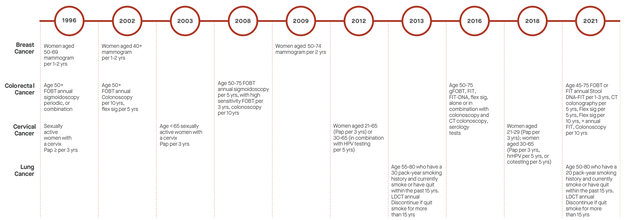
RESEARCH OBJECTIVES

- Cancer mortality has reduced significantly during the last few decades.[1] This has been accomplished by public health measures (e.g. reduction in tobacco use), better and expanded screenings that allow cancer diagnoses at earlier stages, and more efficacious treatments.[2]
- Currently, the U.S. Preventive Services Task Force (USPSTF; A or B rating) recommends single cancer screening for breast, cervical, colorectal, and lung cancer for at-risk individuals.[3-6] The eligibility criteria of screening population and type of screening technologies have evolved over time (**Figure 1**).

Figure 1. Screening Protocols Recommended by USPSTF Over Time for Four Cancer Types

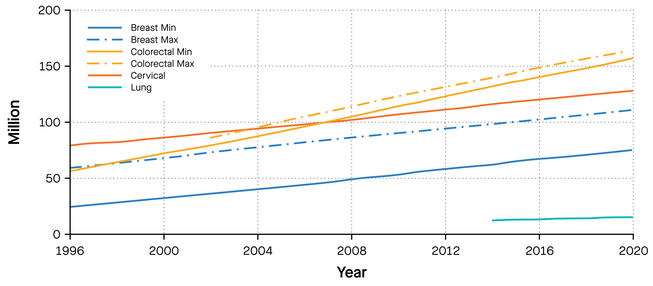


CT, computerized tomography; FIT, fecal immunochemical test; Flex sig, flexible sigmoidoscopy; FOBT, fecal occult blood test; gFOBT, guaiac fecal occult blood test; HPV, Human Papilloma Virus; hrHPV, high-risk Human Papilloma Virus; LDCT, low-dose computerized tomography; Pap, Pap smear or pap test; yrs, years.

- The evidence of the aggregate benefits of existing single cancer screenings following USPSTF recommendations has been limited. In addition, new multi-cancer early detection (MCED) blood tests that can simultaneously screen for multiple types of cancer have been developed.[7-9] Given the recency of the technology, the value of MCED tests has not been fully quantified yet.
- The objective of this research was to estimate the aggregate gains in US life expectancy to date from the introduction of the four major single cancer screening technologies since their USPSTF recommendations.
- This research will help to provide benchmarks for the quantification of the potential value of MCED tests.

KEY RESULTS: THE TOTAL CUMULATIVE FULL POTENTIAL BENEFITS OF SINGLE CANCER SCREENINGS ARE 15.5-21.3 MILLION LIFE YEARS SAVED FROM USPSTF RECOMMENDATION TO 2020

Figure 4. Cumulative Number of Eligible Individuals From USPSTF Recommendation to 2020



- The number of the US population eligible for colorectal cancer screening increased the most over time to over 150 million individuals in 2020 (**Figure 4**).
- The number of individuals eligible for lung cancer is the lowest among the four cancer types, given the high-risk requirement from the USPSTF recommendation.
- The full potential of these technologies under full adherence was estimated to be approximately 15.5-21.3 million life years (**Table 2**).
- The share attributed to each cancer type ranged from 14-23% (2.2-4.9 million life years) for breast, 58-74% (11.4-12.3 million life years) for cervical, 9-17% (1.4-3.6 million life years) for colorectal, and 2-3% (0.5 million life years) for lung cancers (**Table 2**).
- Considering the evidence on a lack of full adherence to the USPSTF recommendations, the aggregate number of life years saved was approximately 12.2-16.2 million across the four cancer types, or about three-quarters of the full potential benefit (**Table 2**).

Table 2. Value of Cancer Screenings From USPSTF Recommendation to 2020

Cancer Type	Total Cohort Size of Eligible Individuals (Millions of People)	Full Potential Life Years Saved (Millions of Life Years)	Value of the Full Potential Life Years Saved (Trillions $)	Life Years Saved Considering Adherence (Millions of Life Years)	Value of the Life Years Saved Considering Adherence (Trillions $)
Breast	75-110	2.2-4.9	$1.2-2.6	1.6-3.6	$0.8-1.9
Cervical	128	11.4-12.3	$6.1-6.5	9.9-10.6	$5.2-5.7
Colorectal	157-164	1.4-3.6	$0.8-1.9	0.7-1.9	$0.4-1.0
Lung	15	0.5	$0.3	0.08	$0.04
Total	**375-417**	**15.5-21.3**	**$8.2-11.3**	**12.2-16.2**	**$6.5-8.6**

- Using a standard measure of the value of a statistical life year ($531,501 based on systematic review),[10] we find an aggregate value of these screening technologies of between $8.2-11.3 trillion at full potential and $6.5-8.6 trillion considering lack of full adherence (**Table 2**).
- Using the same method, considering that MCED tests are intended for use in adults with an elevated risk for cancer, such as those aged 50 or older[18] and modeling data has estimated that MCED tests could provide approximately 0.18 life year gained per tested individual by testing more than 50+ types of AJCC cancer types,[19] the 5 year full potential benefits of MCED tests were estimated to be more than 23 million life years gained, which is more than the total benefits across the screenings for the four cancer types assessed in this study.

CONCLUSIONS

- Cancer screenings have offered significant cumulative values to the US population, despite a non-trivial gap between the full potential benefit and the actual realized benefit considering adherence.

Relevance to Policy, Delivery, or Clinical Practice

- These analyses suggest that technologies and policy interventions that can improve adherence to existing screening and/or expand the number of cancer types screened for can offer great benefit to society.

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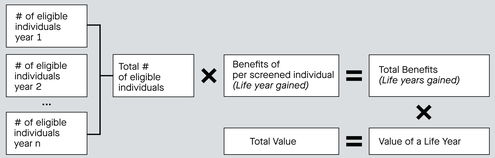
STUDY DESIGN

Estimating the Full Potential Value of Single Cancer Screening

- The total number of eligible individuals in the first year of the USPSTF recommendation and the number of individuals who newly became eligible in subsequent years were estimated using US Census data (**Figure 2**).
- The total number of eligible individuals over time was calculated by taking the summation of the numbers of eligible individuals across all birth cohorts.
- The effectiveness of the four cancer screenings in terms of life year gained was obtained from a targeted literature review.
- The total life years saved were calculated by multiplying the total number of eligible individuals for each cancer screening by the life years gained from that screening.
- The full potential value of cancer screenings was calculated by applying the value of a life year ($531,501 based on systematic review[10]) to the estimated full potential life years gained.

Figure 2. Methodology to Estimate the Full Potential Value of Cancer Screening



Model Inputs

Table 1. Minimum and Maximum Scenario Eligible Population and Effectiveness

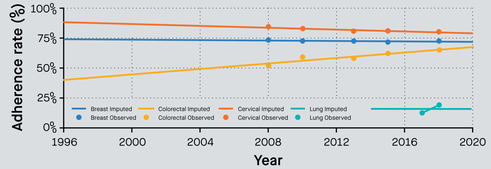
Cancer Type	Minimum Scenario			Maximum Scenario		
	1st Year USPSTF Recommendation	Eligible Population	Life Years Gained per Screened Individual	1st Year USPSTF Recommendation	Eligible Population	Life Years Gained per Screened Individual
Breast	1996	Women; age 50-69	0.029[11]	1996	Women; age 40+	0.044[11]
Colorectal	1996	Age 50-75	Flex sig + FIT*: 0.009[12]	2002	Age 45-75	Colonoscopy: 0.022[12]
Cervical	1996	Women; age 21-65	Pap** 0.089[13]	1996	Women; age 21-65	21-30 Pap; 30-65 Cotesting***: 0.096[13]
Lung	2014	Current smoker or former smoker; age 50-80	0.0316[14]	Limited benefit evidence, same as minimum scenario		

*Flex sig, Flexible sigmoidoscopy, an endoscopic procedure that allows a doctor to examine the rectum and lower colon; FIT, the fecal immunochemical test is a screening test for colon cancer. It tests for hidden blood in the stool, which can be an early sign of cancer.
**Pap: A Pap smear or Pap test is a screening test for cervical cancer.
***Cotesing: A combination of Pap and Human Papilloma Virus testing.

Estimating the Range of Values

- A minimum scenario was assessed using the most restrictive screening population (smallest size of eligible cohort) that the USPSTF ever recommended and a maximum scenario with the least restrictive screening population (largest size of eligible cohort) that the USPSTF ever recommended. For the benefits, we apply the life years gained from the screening test with the lowest/highest effectiveness reported in the literature ever recommended by the USPSTF, respectively (**Table 1**).

Figure 3. Observed and Imputed Cancer Screening Adherence Rates Over Time[15-17]



Estimating the Value of Cancer Screenings Considering Adherence

- The total number of eligible individuals was weighted by each cancer screening's adherence rates for each year. We used publicly available data sources from the National Health Interview Survey (NHIS) for the cancer screening adherence rates and imputed the adherence rates in each year using a linear extrapolation (**Figure 3**).