

TECHNICAL REPORT

NORC Cancer Detection Tool

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PRESENTED BY:
NORC
at the University of Chicago

Technical Report

Study Objective and Overview

The study objective was to estimate the percentage of cancers detected by screening (PCDS) in the United States in 2017 with a primary focus on 4 specific cancers—breast, cervical, colorectal, and lung cancer—for which screening tests are recommended for groups with elevated risk. The study also estimated the PCDS for prostate cancer, which has a widely available screening test but is not widely recommended by the federal government. As a result, prostate cancer estimates are held separately from the other estimates throughout the analysis.

We sought to estimate PCDS by age group and state. At a national level, we also estimate PCDS by racial and ethnic group. We used a similar framework for three of the cancers (breast, cervical, and colorectal), and alternative approaches for the other two (lung and prostate) to address data limitations. This technical report first describes the approach used to estimate PCDS for breast, cervical, and colorectal cancers, and then describes the approach used for lung and prostate.

Results from this analysis are presented on an interactive website, located at <https://cancerdetection.norc.org/>.

Definitions

- **PCDS** estimates the percent of diagnosed cancers that were detected by a USPSTF recommended preventive screening test. PCDS methodology was developed by researchers at NORC. Lower PCDS equates to fewer cancers detected by screenings. Higher PCDS means more cancers are detected by screenings.
- **Cancer Incidence** is the number of new cancer cases diagnosed in a specified population in the past year, usually expressed as the number of new cancers diagnosed per 100,000 population at risk. NORC derived the annual cancer incidence from the National Cancer Institute (NCI) United States Cancer Statistics.
- **Screening Rate** is the number of preventive screenings for a specific cancer site/type in a specified population in the past year. This analysis derived the national screening rate from the National Health Interview Survey (NHIS).

1.0 Analytic Model of PCDS for Breast, Cervical, and Colorectal Cancers.

We estimated PCDS for breast, cervical, and colorectal cancers by specifying an equation to capture the concept of PCDS and populating the equation with data from publicly available sources including national, population representative surveys, and published studies. The equation used to estimate PCDS for each of the three cancer types (breast, cervical, colorectal) was:

$$PCDS_{g,s} = \frac{SR_g * SM_{g,s} * SRA * Pop_{g,s} * CDR_g}{I_{g,s}}$$

With terms defined in table 1. The intuition behind this model is that the PCDS is equal to the estimated number of cancers detected as the result of screening divided by the incidence of all cancers that occurred in a given year. The number of cancers detected by screening can be estimated using secondary data sources described below.

Table 1. Components of Analytic Model for the Percent of Cancers Detected by Screening

Model Element	Element Description	Survey/ Sources
<i>PCDS</i>	Percent of cancers detected by screening	Results of the equation
<i>SR</i>	National screening rate estimated for each subgroup	National Health Interview Survey, 2017 – screened by indicated test in the past 12 months as the result of routine screening or as the results of a screening indication.
<i>SM</i>	State multiplier – measures the relative screening rate above or below the national average in each state $SM = \frac{\textit{State Testing Rate}}{\textit{National Testing Rate}}$	Behavioral Risk Factor Surveillance System (BRFSS), 2017 – tested in the past 12 months
<i>SRA</i>	Positive predictive value for self-report adjustment of screening	The probability that a person who self-reported screening, was screened. Obtained from published studies.
<i>Pop</i>	The population of the subgroup	American Community Survey, 2017 – population count
<i>CDR</i>	Cancer detection rate. Proportion of screening tests that result in a positive cancer detection.	Published studies – cancers detected per screening test
<i>I</i>	The annual incidence of cancer by type and subgroup	National Cancer Institute, U.S. Cancer Statistics, 2017
<i>g</i>	Subgroup (age group, sex, race/ethnicity)	
<i>s</i>	State	

1.1 Screening Rate (SR). We defined the screening rate as the estimated proportion of persons who responded yes to screening questions for the relevant screening test in the past 12 months using the questions below from the 2018 National Health Interview Survey (NHIS) Cancer Control Supplement. For breast, cervical, and colorectal cancers, we measured screening in the last year using a series of three questions indicating that the person had (1) received the test in their lifetime; (2) been tested in previous 12 months; and (3) reported the reason for the test was part of a routine exam. For colorectal cancer, we also included individuals who indicated their colonoscopy or sigmoidoscopy was a follow-up test of an earlier screening exam, since these tests are often used to confirm positive results on other colorectal cancer screenings. In the model, the national screening rate was used as the initial basis, which was then adjusted to estimate state variation in screening rates from the BRFSS to produce state level results. We estimated this screening rate for each applicable subgroup (Section 1.7). Specifically, for each cancer, we used the following NHIS questions to indicate the respondent had been screened:

Breast Cancer Screening

1. Have you EVER HAD a mammogram? Response = yes
2. When did you have your MOST RECENT mammogram? Response = A year ago or less
3. What was the MAIN reason you had this mammogram—was it part of a routine exam, because of a problem, or some other reason? Response= Part of a routine exam

Cervical Cancer Screening

1. Have you EVER HAD a Pap smear or Pap test? Response = Yes
2. When did you have your MOST RECENT Pap test?
Response = A year ago or less
3. What was the MAIN reason you had this Pap test—was it part of a routine exam, because of a problem, or some other reason? Response= Part of a routine exam

Colon Cancer Screening

1. There are several different kinds of tests to check for colon cancer. Colonoscopy (colon-OS-copy) and sigmoidoscopy (sigmoid-OS-copy) are exams in which a doctor inserts a tube into the rectum to look for polyps or cancer. For a colonoscopy, the doctor checks the entire colon, and you are given medication through a needle in your arm to make you sleepy, and told to have someone drive you home. For a Sigmoidoscopy, the doctor checks only part of the colon and you are fully awake. Have you EVER HAD a colonoscopy? Response = Yes
2. When did you have your MOST RECENT colonoscopy? Response = A year ago or less
3. What was the MAIN reason you had this colonoscopy - was it part of a routine exam, because of a problem, as a follow-up test of an earlier test or screening exam, or some other reason? Response = Part of a routine exam OR Follow-up test of an earlier test or screening exam

1.2 State Multiplier (SM). The NHIS provides estimates of screening tests that occurred in the last year by demographic group at the national level. However, NHIS does not provide information by state. We used data on overall testing from the CDC’s Behavioral Risk Factor Surveillance System (BRFSS) to estimate variation in screening by state. BRFSS asks whether a person has ever had a each of the cancer tests (mammogram, pap test, or colonoscopy), and if yes, when this testing occurred. Because these questions are not able to differentiate between testing for screening purposes, or testing for other purposes, we used the NHIS estimates (1.1) to estimate the mean level of screening tests across all states, and then used the BRFSS estimates to adjust the national testing mean in each state using a rate ratio of the rate observed in each state and population group divided by the national rate for that group, both estimated in the BRFSS.

$$SM_{g,s} = \frac{\text{State Testing Rate}_{g,s}}{\text{National Testing Rate}_g} \quad (2)$$

This method assumes that screening in each state and for each group varies compared to the national rate of screening in the same way that all testing in the last year in each state for a given group varies from the national rate of testing in the last year as measured in the BRFSS.

1.1 Self-Report Adjustment (SRA). Our model accounts for inaccuracies in self-reports of screening by adjusting these estimates using published estimates of the self-report adjustment or “positive predictive value (PPV)” of a self-report of screening in measuring the occurrence of actual screening. PPV is a measure of the percentage of respondents who responded yes to a measure who accurately experienced the measure. In published studies, it is estimated using comparisons of self-reported measures to a gold standard measure observed in clinical or observational data. Multiplying the self-reported screening rate by the self-report adjustment (SRA) has the effect of reducing the proportion of individuals identified as having cancer screening. The model does not adjust for any individuals who inaccurately reported not having a screening. We obtained positive predictive value (PPV) from published studies using values from Salas, et al (2014) for colonoscopies, values from Alsheik, et al (2021) for mammograms, and values from Ito, et al (2019) for pap smears. (Alsheik et al., 2021; Ito et al., 2020; Salas et al., 2014)

1.2 Population (POP). To estimate the count of persons screened, we multiply the adjusted screening rate (estimated using 1.1 1.2, and 1.3) by the estimated population size in each demographic group in each state. We estimated population using American Community Survey 1-year estimates for the year 2017.

1.3 Cancer Detection Rate (CDR). We multiplied the estimated number of persons screened for cancer by the estimated cancer detection rate per persons tested. We obtained CDR's from published studies using values from Salas, et al (2014) for colonoscopies, values from Alsheik, et al (2021) for mammograms, and values from Ito, et al (2019) for pap smears. (Alsheik et al., 2021; Ito et al., 2020; Salas et al., 2014)

1.4 Incidence (I). The denominator of our estimate is the number of incident cancers reported by the National Program of Cancer Registries (NPCR) in the NPCR and SEER Incidence – US Cancer Statistics Public Use Database, 2019 Submission (2001-2017) as reported for the year 2017 only. We used SEER software to estimate incident cancers in 2017 nationally, by state, and by group (described in 1.7).

1.5 Group (g). We created estimates by age group, sex (for colonoscopies only), and at the national level by race ethnicity groups. We estimated the following age groups:

- Ages 40 to 49
- Ages 50 to 64
- Ages 65 to 79

And the following mutually exclusive race/ethnicity groups:

- Asian/Pacific Islanders, non-Hispanic
- American Indian/Alaskan Native, non-Hispanic
- Black, non-Hispanic
- Other Race, non-Hispanic
- White, non-Hispanic
- Hispanic

PCDS estimates are not displayed for all racial and ethnic groups and are only displayed nationally due to small sample sizes and unstable estimates.

1.6 State (s). State indicates the state for which the estimate was generated.

2. Lung Cancer Estimates. Annual lung cancer screening (LCS) with low-dose chest computed tomography has been recommended for older adults with a current or former smoking risk since 2013. Data on LCS for the targeted year of this analysis (2017) are limited. However, a recently published paper estimated LCS rates among the eligible populations of persons with a smoking risk for the years 2016-2018 using data from The American College of Radiology’s Lung Cancer Screening Registry. (Fedewa et al., 2021) Our project uses these published population level rates (i.e. without stratification by age-group, sex, or race/ethnicity) for the year 2017. These rates are then combined with published literature about test CDR and incidence to estimate the PCDS using steps 1.4 and beyond described above. We rely on published estimates on smoking history to estimate the portion of the population and lung cancers in individuals who are recommended for screening (Pinskey et al., 2012). We assume lung cancers are equally likely to be deadly when they occur in the screen eligible or screen ineligible population.

3. Prostate Cancer Estimates. We were unable to estimate reliable indicators of prostate cancer using equation 1 because multiplying screening estimates from survey data by published CDRs for prostate cancer detection resulted in vastly more cases of prostate cancer than the NPCR estimates of incident prostate cancers in 2017. This could be the result of (1) men (only men are indicated for prostate cancer screening) overreporting prostate cancer screening; (2) published CDRs relate in part to cancers that would not be reported to NPCR in cancer registries; (3) under-reporting of prostate cancers of all types to NPCR, or (4) other unknown reasons. Regardless of the reasons, applying the equation above to prostate screening, CDR, and incidence data resulted in nonsensical estimates.

As an alternative, we estimated the PCDS of prostate cancer using NPCR data on incident cancers reported by histologic grade based roughly on Gleason score criteria as categorized in the NPCR data. Specifically, we estimated the PCDS of prostate cancer as:

$$\frac{\textit{Prostate Cancers Reported in Grades 1 and 2}}{\textit{All Reported Prostate Cancers}} \quad (3)$$

As reported in NPCR data, grade 1 and 2 cancers encompass all cancers with a histological grade of “well differentiated” or “moderately differentiated” encompassing those cancers with a Gleason score of 2 through 6. (National Cancer Institute, 2022) We assume that all grade 1 and 2 prostate cancers were detected by screening. We assumed cancers detected with a histological grade of “poorly differentiated” (Gleason score of 7 through 10) represented a screening failure, even though these cancers may have also been detected by a screening test.

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