Original Investigation

Cancer Screening Rates in Individuals With Different Life Expectancies

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IMPORTANCE Routine cancer screening has unproven net benefit for patients with limited life expectancy.

OBJECTIVE To examine the patterns of prostate, breast, cervical, and colorectal cancer screening in the United States in individuals with different life expectancies.

DESIGN, SETTING, AND PARTICIPANTS Data from the population-based National Health Interview Survey (NHIS) from 2000 through 2010 were used and included 27 404 participants aged 65 years or older. Using a validated mortality index specific for NHIS, participants were grouped into those with low (<25%), intermediate (25%-49%), high (50%-74%), and very high (≥75%) risks of 9-year mortality.

MAIN OUTCOMES AND MEASURES Rates of prostate, breast, cervical, and colorectal cancer screening.

RESULTS In participants with very high mortality risk, 31% to 55% received recent cancer screening, with prostate cancer screening being most common (55%). For women who had a hysterectomy for benign reasons, 34% to 56% had a Papanicolaou test within the past 3 years. On multivariate analysis, very high vs low mortality risk was associated with less screening for prostate (odds ratio [OR], 0.65 [95% CI, 0.50-0.85]), breast (OR, 0.43 [95% CI, 0.35-0.53]), and cervical (OR, 0.50 [95% CI, 0.36-0.70]) cancers. There was less screening for prostate and cervical cancers in more recent years compared with 2000, and there was no significant interaction between calendar year and mortality risk for any cancer screening ($P > .05$ for all cancers). Our sensitivity analysis showed that screening was also common in individuals with less than 5-year life expectancy.

CONCLUSIONS AND RELEVANCE A substantial proportion of the US population with limited life expectancy received prostate, breast, cervical, and colorectal cancer screening that is unlikely to provide net benefit. These results suggest that overscreening is common in both men and women, which not only increases health care expenditure but can lead to net patient harm.

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Healthy People 2020, an initiative released by the US Department of Health and Human Services, defined our nation's current public health priorities in prevention and health promotion.[1,2] In the context of cancer, Healthy People aims to increase the proportion of individuals who receive screening consistent with the US Preventive Services Task Force (USPSTF)'s evidence-based guidelines. These guidelines include not only indications for cancer screening but also cessation of screening for some conditions when there is no evidence for net benefit or when evidence suggests screening may lead to net harm. Healthy People specifically recommends using data from the National Health Interview Survey (NHIS) to quantify progress in achieving these goals.[2]

There is general agreement that routine cancer screening has little likelihood to result in a net benefit for individuals with limited life expectancy,[3,4] as reflected in the consistency in existing guidelines. The American Society of Clinical Oncology (ASCO), as part of their Choosing Wisely Campaign, an initiative designed to highlight the misuse of medical tests, recently recommended avoiding prostate-specific antigen (PSA) screening in men who are expected to live fewer than 10 years.[5] Similarly, the American Cancer Society (ACS) and the American Urological Association (AUA) also recommend cessation of PSA screening in men with a life expectancy of less than 10 years.[6,7] For colorectal cancer screening, the American College of Physicians recommends cessation of screening in

individuals with less than 10-year life expectancy.[8] Other guidelines in breast[9] and cervical cancers[10,11] have similarly used life expectancy and/or age[12-14] (a crude surrogate for life expectancy) as a parameter for screening cessation. A summary of selected guidelines is presented in **Table 1**. The routine use of cancer screening in these individuals not only has implications for utilization of health care resources in a setting unlikely to result in net benefit but may also cause net patient harm owing to subsequent diagnostic procedures and overtreatment.[3]

The objective of this study is to examine the patterns of routine prostate, breast, cervical, and colorectal cancer screening in the United States using data collected from the population-based NHIS and to assess whether rates of cancer screening differ in individuals with different life expectancies. This study allows comparison of one aspect of current practice with the goal of Healthy People to promote evidence-based uses of cancer screening.

Table 1. Summary of Cancer Screening Cessation Criteria in Select Guidelines

Cancer	Organization	Recommendation
Prostate	USPSTF	Recommend against PSA-based screening for all men[15]
	ASCO	<10-y life expectancy[5]
	ACS	<10-y life expectancy[6]
	AUA	Age ≥70 y or <10-15-y life expectancy[7]
Breast	USPSTF	Age ≥75 y[12]
	SBI, ACR	<5-7-y life expectancy[9]
	CTFPHC	Age ≥75 y[13]
Cervical	USPSTF	Age >65 y,[10] hysterectomy with removal of the cervix, without history of a high-grade precancerous lesion or cervical cancer[10]
	ACS, ASCCP	Age >65 y[11]
	ASCP	Hysterectomy[11]
Colorectal	USPSTF	Age >85 y (for ages 76-85 y, recommend individualized decisions)[14]
	ACP	Age >75 y or <10-y life expectancy[8]

Abbreviations: ACP, American College of Physicians; ACR, American College of Radiology; ACS, American Cancer Society; ASCCP, American Society for Colposcopy and Cervical Pathology; ASCO, American Society of Clinical Oncology; ASCP, American Society for Clinical Pathology; AUA, American Urological Association; CTFPHC, Canadian Task Force on Preventive Health Care; PSA, prostate-specific antigen; SBI, Society of Breast Imaging; USPSTF, US Preventive Services Task Force.

Methods

Data Source and Study Cohort

The NHIS is a cross-sectional, in-person survey conducted by the National Center for Health Statistics, and studies approximately 90 000 persons each year using a stratified, multistage sampling design to provide information representative of the US population.[16] Hispanics and African Americans are oversampled.[16] Data from the NHIS have been used widely to examine population-based patterns of health care in the United States.[17,18] Institutional review board approval for this study was waived by the University of North Carolina.

A total of 143 592 participants were asked cancer screening questions in NHIS survey years 2000, 2003, 2005, 2008, and 2010, including 27 911 participants 65 years or older. The index used to calculate mortality risk is validated only in individuals 65 years or older. Excluding those with missing data necessary for life expectancy calculations (507), a total of 27 404 were included in the analysis.

Outcomes

Receipt of screening tests was collected by self-report,[19,20] and time period of assessment was based on commonly recommended screening frequencies, consistent with prior methods using NHIS data.[21] Prior studies have described the sensitivities of self-reported cancer screening rates for mammograms, Papanicolaou tests, PSA tests, and endoscopies at 0.95, 0.93, 0.71, and 0.79, respectively; specificities are 0.61, 0.48, 0.73, and 0.90, respectively.[22] Breast cancer screening was defined as having a mammogram in the past 2 years,[12] and cervical cancer screening as having a Papanicolaou test in the past 3 years[10]—both based on USPSTF recommendations. Colorectal cancer screening was defined as having any screening examination (colonoscopy, sigmoidoscopy, or fecal occult blood test) in the past 5 years.[14] The optimal frequency, if any, of prostate cancer screening is controversial, and the USPSTF recommends no PSA screening.[15] For purposes of this study, we defined prostate cancer screening as having had a PSA test in the past 2 years, which is consistent with the screening interval recommended by the AUA.[7]

To calculate the screening rates of each type of cancer, we excluded those who had a history of the cancer in question. In addition, to calculate the rates of cervical cancer screening, we excluded those with a history of hysterectomy and those with a history of cervical, uterine, or ovarian cancer. However, we separately calculated the rates of cervical cancer screening (Papanicolaou tests) in women with a history of hysterectomy for benign reasons (ie, history of hysterectomy and no history of cancer). For cervical cancer screening, data from 2003 could not be used because a question about prior hysterectomy was not included in that survey year. Only women were included in the cervical and breast cancer screening analyses, only men were included in the prostate cancer screening analysis, and both men and women were included in the colorectal cancer screening analysis.

Control Variables

A validated mortality index based on NHIS data, with a C statistic of 0.75, was used to calculate 9-year mortality risk for each participant.[23] The index was designed specifically for cancer screening applications and for participants 65 years or older, and incorporates age, sex, smoking status, body mass index, comorbid conditions, number of hospitalizations, perceived health, and functional measures.[23,24] We grouped participants into those with a low likelihood of mortality (<25% risk of mortality in 9 years), intermediate likelihood (25%-49%), high likelihood (50%-74%), and very high likelihood (≥75%). Nine-year life expectancy was chosen for the main analysis because a validated mortality index exists, and this duration is

similar to the 10-year cutoff used by many existing guidelines for cancer screening cessation.[5-8]

The NHIS collected participant-level sociodemographic variables, including race, age, marital status, education, region, insurance status, and usual place of medical care.

Statistical Analysis

The proportions of participants who received screening for each cancer were calculated for subgroups stratified by mortality risk, and χ^2 tests were used to assess potential differences among groups. As a sensitivity analysis, we also calculated screening rates based on 5-year mortality risk, using a validated 5-year mortality index, which also has a C statistic of 0.75.[24] Of note, this 5-year mortality index does not provide risks of 75% or higher; therefore, a very high risk group was not created for analysis. Logistic regression models were used to assess potential factors associated with screening, and a separate model was built for each cancer. A Year × Mortality Risk interaction term was tested in all models to assess whether trends in screening over time differed by groups with different life expectancies. All analyses incorporated population-based sampling weights provided by NHIS unless otherwise indicated.

Statistical analysis was conducted using SAS software (version 9.2; SAS Institute Inc). Two-sided *P* values were calculated, with $P < .05$ considered statistically significant.

Results

Table 2 describes the weighted characteristics of the 27 404 participants included in this study, stratified by mortality risk group. Overall, 87% were white, and 41% were married. Almost all (99%) had health insurance, as one would expect for this Medicare-eligible population, and 96% identified having a place for usual health care. There was diversity in educational levels and geographic regions in the participants.

Figure 1 and the eTable in the Supplement show the screening rates for prostate, breast, cervical, and colorectal cancers stratified by 9-year mortality risk. The overall screening rates for the study cohort were prostate cancer, 64% (range, 70% in individuals with low mortality risk to 55% in those with very high mortality risk); breast cancer, 63% (range, 74% [low] to 38% [very high]); cervical cancer, 57% (range, 70% [low] to 31% [very high]); and colorectal cancer, 47% (51% [low] to 41% [very high]). Among different cancers, the rate of recent screening in those with a very high mortality risk was highest for prostate cancer (55%). In all cancers, screening rates decreased as the risk of mortality increased ($P < .001$ for all cancers). In sensitivity analysis, screening rates ranged from 26% to 52% for participants with high (≥50%) 5-year mortality risk (**Figure 2**). Screening rates by NHIS survey year are detailed in eFigures 1 to 4 in the Supplement.

We further examined screening rates based on age groups because some guidelines (eg, those of the USPSTF) use age criteria rather than life expectancy. The USPSTF does not recommend prostate cancer screening for men of any age. For breast cancer, screening rates were 55% (for those ≥75 years) and 72% (for those <75 years). For cervical cancer, screening rates were 56% (for those >65 years) and 75% (for those ≤65 years). For colorectal cancer, rates were 31% (for those ≥85 years), 46% (for those 75-84 years), and 50% (for those <75 years).

For participants who had a hysterectomy for benign reasons, Papanicolaou test was received by 56% (low mortality risk), 45% (intermediate mortality risk), and 34% (high mortality risk) of participants within the past 3 years.

Table 3 summarizes the multivariate models examining factors associated with cancer screening. Increasing risk of mortality was associated with decreased odds of screening for all but colorectal cancer. In addition, older age was independently associated with less screening for all cancers. For prostate cancer, age older than 84 years was associated with decreased screening compared with those ages 65 to 69 years (odds ratio [OR], 0.69 [95% CI, 0.50-0.94]). For breast (age 75 years), cervical (age 70 years), and colorectal (age 80 years) cancers, decreased rates of screening seemed to start at younger ages. Participants who were married, had more education, had insurance coverage, or had a usual place of care were more likely to receive screening. Screening decreased for prostate and cervical cancers in more recent years compared with 2000. A Year × Mortality Risk interaction term was tested and was found to be nonsignificant in all 4 models ($P = .34$ for prostate cancer; $P = .58$, breast cancer; $P = .63$, cervical cancer; $P = .52$, colorectal cancer), so it was not retained in the final models.

Discussion

In this study, we used recent results from the population-based NHIS to examine the rates of prostate, breast, cervical, and colorectal cancer screening in groups of individuals with different levels of 9-year and 5-year life expectancies based on validated NHIS-specific mortality indices. We found that groups of individuals with higher risks of mortality (ie, lower life expectancy) had lower rates of prostate, breast, and cervical cancer screening. Still, a sizable proportion of the US population who have a less than a 9-year life expectancy (≥75% mortality risk) received cancer screening, including 55% in the group who received prostate cancer screening. When examined by age criteria, which are used by certain guidelines, such as those of the USPSTF, a similar finding emerged of a large proportion of individuals receiving cancer screening who are not recommended by guidelines. While prostate and cervical cancer screening rates decreased in more recent years compared with 2000, this trend did not have a differential impact on individuals in different life expectancy groups.

To our knowledge, this is the first study to examine the population-based screening patterns for all 4 cancers by life expectancy. While overscreening in prostate cancer has been widely reported,[25,26] whether overscreening occurs on a population-level in other cancers has not been well studied. Furthermore, our use of life expectancy is important, and there is increasing recognition in the literature and published guidelines that age alone is insufficient to determine appropriateness of screening. A recent report by Bellizzi et al[27] used NHIS data to examine rates of prostate, breast, cervical, and colorectal cancer screening in 2005 and 2008 among individuals 75 years or older but recognized that screening in older indi-

Table 2. Characteristics of the 27 404 National Health Interview Survey Participants Included in This Study[a]

Mortality Risk Over 9 y	No. (%)				
	Low (<25%) (n = 8263)	Intermediate (25%-49%) (n = 8655)	High (50%-74%) (n = 6263)	Very High (≥75%) (n = 4223)	Total (n = 27 404)
Age, y					
65-69	4297 (52)	2246 (25)	845 (13)	229 (5)	7617 (27)
70-74	2747 (33)	2447 (27)	1005 (15)	343 (7)	6542 (23)
75-79	1013 (12)	2379 (28)	1541 (24)	731 (17)	5664 (21)
80-84	206 (3)	1254 (15)	1685 (27)	1119 (26)	4264 (16)
≥84	0	329 (4)	1187 (20)	1801 (45)	3317 (13)
Marital status					
Married	3902 (49)	3788 (44)	2166 (35)	1350 (32)	11 206 (41)
Unmarried	4325 (52)	4848 (56)	4084 (65)	2866 (68)	16 123 (58)
Missing data	36 (<1)	19 (<1)	13 (<1)	7 (<1)	75 (<1)
Education					
<High school graduate	3012 (30)	3652 (36)	3011 (43)	2275 (48)	11 950 (38)
High school graduate	1477 (21)	1575 (22)	1144 (22)	689 (19)	4885 (21)
Some college	1959 (25)	1828 (22)	1206 (20)	668 (18)	5661 (22)
College graduate	1725 (24)	1526 (19)	826 (14)	506 (13)	4583 (18)
Missing data	90 (<1)	74 (<1)	76 (1)	85 (2)	325 (<1)
Health insurance					
Yes	8134 (99)	8570 (99)	6220 (99)	4193 (99)	27 117 (99)
No or unknown	129 (1)	85 (1)	43 (1)	30 (1)	287 (1)
Have a place for health care					
Yes	7834 (96)	8294 (96)	6057 (97)	4122 (97)	26 307 (96)
No usual place of care	392 (4)	338 (4)	193 (3)	90 (2)	1013 (4)
Missing data	37 (<1)	23 (<1)	13 (<1)	11 (<1)	84 (<1)
NHIS year					
2000	1913 (16)	1955 (16)	1333 (15)	877 (14)	6078 (16)
2003	1705 (17)	1801 (17)	1253 (16)	869 (16)	5628 (17)
2005	1736 (16)	1901 (17)	1387 (17)	939 (17)	5963 (16)
2008	1299 (25)	1337 (25)	1032 (26)	684 (26)	4352 (25)
2010	1610 (26)	1661 (26)	1258 (27)	854 (27)	5383 (26)
Race					
White	6953 (88)	7204 (87)	5201 (88)	3468 (87)	22 826 (87)
Nonwhite	1310 (12)	1451 (13)	1062 (12)	755 (13)	4578 (13)
Sex					
Male	1891 (23)	3726 (42)	2698 (43)	2204 (51)	10 519 (38)
Female	6372 (77)	4929 (58)	3565 (57)	2019 (49)	16 885 (62)
Region					
Northeast	1657 (21)	1742 (21)	1188 (20)	772 (19)	5359 (21)
Midwest	1897 (25)	1971 (24)	1478 (24)	1007 (25)	6353 (24)
South	2931 (34)	3159 (36)	2356 (37)	1614 (38)	10 060 (36)
West	1778 (20)	1783 (29)	1241 (19)	830 (18)	5632 (19)

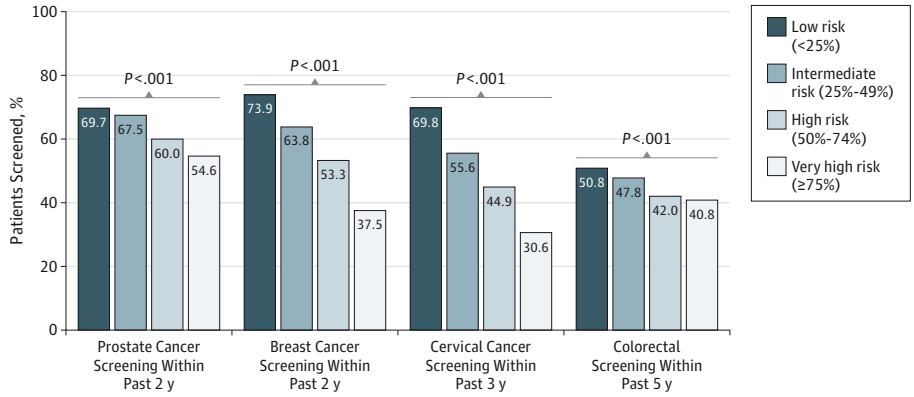
Abbreviation: NHIS, National Health Interview Survey.

[a] Numbers shown are crude numbers. Percentages were calculated using population-based sampling weights provided by the NHIS.

viduals who are healthy may indeed be appropriate.[27,28] Like the study by Bellizzi et al,[27] prior studies examining screening rates in the United States were limited by a lack of comorbidity and health status data, which are important in clinical decision-making and necessary for calculation of individual life expectancy. Age alone is insufficient to assess whether an individual is likely to have net benefit from screening or to evaluate whether overscreening occurs on a population level.[26-28] Emphasizing this, the American College of Physicians recently recommended basing decisions to screen for prostate cancer in part on the patient's general health and life expectancy, as does the 2013 ASCO Choosing Wisely recommendations.[5,29] This study is timely based on these recent recommendations and also provides data on screening trends over the past 10 years. While our results demonstrate that physicians and patients do take life expectancy into consideration, they raise concerns about overscreening in individuals who are unlikely to have net benefit from it.

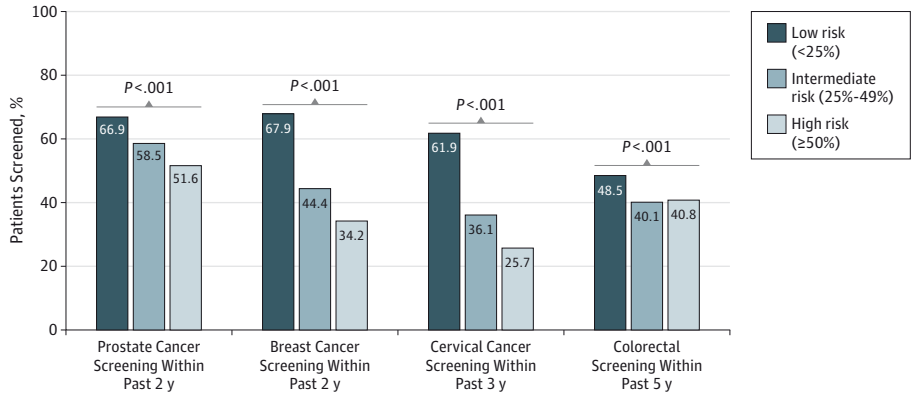
In published guidelines, 10-year life expectancy is commonly used for clinical decision-making regarding cancer

Figure 1. Screening Rates Stratified by 9-Year Mortality Risk



Percentages represent crude rates calculated using population-based sampling weights provided by National Health Interview Survey. Unweighted sample sizes: prostate cancer screening, n = 5701; breast cancer screening, n = 11 251; cervical cancer screening, n = 5024; colorectal cancer screening, n = 17 900.

Figure 2. Screening Rates Stratified by 5-Year Mortality Risk



Percentages represent crude rates calculated using population-based sampling weights provided by National Health Interview Survey. Unweighted sample sizes: prostate cancer screening, n = 5701; breast cancer screening, n = 11 251; cervical cancer screening, n = 5024; colorectal cancer screening, n = 17 900.

screening[5-8] because survival benefits from screening within 10 years are unproven or small. In this study, the 31% to 55% rates of routine cancer screening in individuals with less than a 9-year life expectancy (≥75% risk of mortality in 9 years) demonstrate that guideline-discordant use of cancer screening is common. Rates of overscreening for prostate cancer are especially high, possibly because PSA testing is viewed as a simple, safe blood test, with little recognition of the important downstream harms. Overscreening occurs even in individuals with less than a 5-year life expectancy. These results from the sensitivity analysis further demonstrate the magnitude of overscreening across the United States. It is widely accepted that individuals with less than a 5-year life expectancy will not have net benefit from cancer screening.[3,27,28]

Another guideline-discordant screening we examined was Papanicolaou tests for women who had a hysterectomy for benign reasons.[10] This was received by 34% to 56% of these women, and the finding is consistent with that of a prior report[30] of rates from 1992 to 2002. However, for a small proportion of these women who may have had a hysterectomy but retained their cervix, Papanicolaou tests may be appropriate.

We also found that individuals who were married, had more education, had insurance coverage, or had a usual place of care were more likely to receive screening across all 4 cancers. It is not surprising that individuals with insurance and a usual place of care had more access to cancer screening tests, but our findings suggest that overscreening may be more common in married and more highly educated individuals. The cause of this is unknown but suggests an opportunity for increased educational efforts regarding the potential net benefits and harms of cancer screening, especially in individuals with limited life expectancy.

Our results highlight the challenges to implementing evidence-based screening guidelines on a population level. While the lack of net benefit from cancer screening in individuals with limited life expectancy is widely recognized and publicized in clinical practice guidelines, important obstacles exist to reliably applying these guidelines clinically. One such obstacle is the lack of a readily available and easy-to-use clinical tool to accurately assess life expectancy for each patient[31,32]; the mortality index used in this study may be too cumbersome for clinical use. Without simple and reliable ways to assess 10-year life expectancy in the clinic, guidelines may be impractical for clinical adherence, which may partially explain the findings of this study. Furthermore, even when limited life expectancy is recognized, the physician may have difficulty communicating this prognosis and/or the patient may have difficulty accepting a limited life expectancy or cessation of screening. The prac-

Table 3. Multivariate Logistic Regression Models for Recent Cancer Screening

	Type of Cancer							
	Prostate[a]		Breast[b]		Cervical[c]		Colorectal[d]	
Covariate	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value
9-y Risk of mortality								
Low	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Intermediate	0.88 (0.72-1.06)	.18	0.77 (0.68-0.88)	<.001	0.82 (0.69-0.98)	.03	0.97 (0.88-1.06)	.51
High	0.72 (0.57-0.92)	.007	0.63 (0.54-0.74)	<.001	0.73 (0.58-0.92)	.008	0.93 (0.83-1.05)	.22
Very high	0.65 (0.50-0.85)	.001	0.43 (0.35-0.53)	<.001	0.50 (0.36-0.70)	<.001	1.07 (0.92-1.26)	.37
Age, y								
65-69	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
70-74	1.11 (0.94-1.31)	.22	0.94 (0.82-1.08)	.40	0.68 (0.55-0.84)	<.001	1.09 (0.99-1.20)	.08
75-79	1.47 (1.20-1.79)	<.001	0.83 (0.72-0.96)	.01	0.52 (0.42-0.64)	<.001	1.07 (0.96-1.19)	.24
80-84	1.00 (0.79-1.26)	.98	0.73 (0.62-0.86)	<.001	0.38 (0.30-0.49)	<.001	0.80 (0.70-0.92)	.002
≥84	0.69 (0.50-0.94)	.02	0.38 (0.31-0.46)	<.001	0.23 (0.17-0.31)	<.001	0.47 (0.40-0.56)	<.001
Marital status								
Married	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Unmarried	0.79 (0.69-0.90)	<.001	0.72 (0.65-0.81)	<.001	0.74 (0.62-0.87)	<.001	0.77 (0.72-0.84)	<.001
Education								
Less than high school graduate	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
High school graduate	1.49 (1.22-1.81)	<.001	1.40 (1.19-1.64)	<.001	1.28 (1.06-1.54)	.01	1.27 (1.12-1.43)	<.001
Some college	1.80 (1.48-2.19)	<.001	1.58 (1.38-1.80)	<.001	1.70 (1.41-2.04)	<.001	1.65 (1.50-1.82)	<.001
College graduate	2.28 (1.92-2.71)	<.001	2.16 (1.81-2.57)	<.001	2.06 (1.60-2.66)	<.001	2.00 (1.79-2.23)	<.001
Health insurance								
Yes	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
No or unknown	0.44 (0.25-0.76)	.003	0.43 (0.24-0.78)	.005	0.40 (0.19-0.84)	.02	0.51 (0.33-0.79)	.003
Have a place for health care								
Usual place	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
No usual place	0.19 (0.13-0.26)	<.001	0.16 (0.12-0.21)	<.001	0.21 (0.15-0.30)	<.001	0.21 (0.16-0.28)	<.001
NHIS survey year								
2000	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
2003	1.04 (0.85-1.27)	.72	1.03 (0.90-1.18)	.64	NA[e]	NA[e]	2.15 (1.94-2.38)	<.001
2005	0.45 (0.38-0.54)	<.001	0.77 (0.68-0.88)	<.001	0.61 (0.51-0.73)	<.001	1.31 (1.18-1.46)	<.001
2008	0.56 (0.47-0.69)	<.001	0.82 (0.72-0.95)	.006	0.56 (0.46-0.67)	<.001	2.33 (2.07-2.63)	<.001
2010	0.46 (0.35-0.61)	<.001	0.96 (0.78-1.18)	.67	0.52 (0.40-0.67)	<.001	1.90 (1.65-2.19)	<.001
Race								
White	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Nonwhite	0.83 (0.70-0.99)	.03	1.00 (0.87-1.13)	.94	1.06 (0.88-1.27)	.55	0.84 (0.76-0.92)	<.001
Sex								
Male	NA	NA	NA	NA	NA	NA	1 [Reference]	NA
Female	NA	NA	NA	NA	NA	NA	0.93 (0.85-1.01)	.10
Region								
Northeast	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Midwest	1.11 (0.91-1.35)	.30	1.08 (0.94-1.24)	.30	1.07 (0.88-1.31)	.48	0.97 (0.87-1.09)	.60
South	1.06 (0.89-1.28)	.50	1.04 (0.91-1.20)	.55	1.26 (1.04-1.52)	.02	0.89 (0.80-0.99)	.03
West	0.76 (0.63-0.92)	.005	1.13 (0.97-1.32)	.10	1.08 (0.88-1.33)	.47	0.99 (0.88-1.12)	.89

Abbreviations: NA, not applicable; NHIS, National Health Interview Survey; OR, odds ratio.

[a] Screening defined as a prostate-specific antigen test in the past 2 years.

[b] Screening defined as a mammogram in the past 2 years.

[c] Screening defined as a Papanicolaou test in the past 3 years.

[d] Screening defined as any colorectal screening examination (sigmoidoscopy, colonoscopy, or fecal occult blood test) in the past 5 years.

[e] 2003 Papanicolaou test data excluded because there was no question about prior hysterectomy in this survey year.

tice of defensive medicine and fear of litigation[33-35] may further contribute to overscreening. A prior study[36] that demonstrated routine screenings in patients with advanced cancer showed a similar pattern (though of a smaller magnitude) in another group of individuals in whom omission of screening should be relatively uncontroversial. Together, these studies demonstrate a clear need for research to assess ways that can effectively reduce overscreening.

This study has implications regarding the critical issue of skyrocketing health care costs. Eliminating "waste," or not value-added care, in US health care has been identified as an appropriate way to bring health care expenditure to a sustainable level.[37] Excessive cancer screening in individuals with limited life expectancy has been previously identified as an area of wasteful care.[36] Specifically, the costs of overdetection and overtreatment in prostate cancer have been reported. While the screening test itself (PSA) is not costly, using this test in men who have a limited life expectancy leads to downstream consequences of cancer (over) diagnoses and (over)treatments that are costly and unlikely to provide net benefit to the patient.[38-41] Similar concerns regarding the cost-effectiveness of breast cancer screening in the older populations exist, and the economic benefits of using age with health status as a screening threshold have been advocated.[42] Our study finds overscreening in some of the most common cancers and identifies a significant opportunity: by reducing or eliminating the currently frequent use of cancer screening in individuals with limited life expectancy, we can decrease waste in health care spending and simultaneously improve patient outcomes on a population level by minimizing the unnecessary harms from cancer screening.[43,44]

A limitation of this study is that NHIS data are by participant self-report; the screening rates and other information collected are not confirmed with medical records. A prior study[22] showed that self-reports may underestimate PSA screening rates, although other studies found an overestimation of mammogram and Papanicolaou test screening rates.[22] Despite this limitation, the NHIS has a high annual response rate of close to 90%,[16] and its data are commonly used to examine population-based health care patterns across the United States. It is also the data set that Healthy People 2020 recommends for monitoring health care patterns in this country. Furthermore, although different guidelines have recommended different life expectancies or age cutoffs for cessation of cancer screening, our examination of screening rates in the group of individuals with less than a 9-year life expectancy likely represents a conservative estimate of the rates of overscreening on a population level. Our finding of frequent uses of cancer screening in individuals with less than a 5-year life expectancy further demonstrates the magnitude of this issue.

Conclusions

A substantial proportion of the US population with limited life expectancy received prostate, breast, cervical, and colorectal cancer screening that is unlikely to provide net benefit. These results raise concerns about overscreening in these individuals, which not only increases health care expenditure but can lead to patient net harm. Creating simple and reliable ways to assess life expectancy in the clinic may allow reduction of unnecessary cancer screening, which can benefit the patient and substantially reduce health care costs. There is a considerable need for further dissemination efforts to educate physicians and patients regarding the existing screening guidelines and potential net harm from screening in individuals with limited life expectancy.

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Study concept and design: Royce, Stokes, Allen, Chen.
Acquisition, analysis, or interpretation of data: Royce, Hendrix, Chen.
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Invited Commentary

Cancer Screening in Older Persons
A New Age of Wonder

Cary P. Gross, MD

The process of scientific discovery is, in effect, a continual flight from wonder.
Albert Einstein

The second half of the 20th century was truly an age of wonder for cancer screening. In 1943, when Papanicolaou and Traut[1] first published reports of a new method for cervical cancer screening, cervical cancer was still a major cause of death. By the 1950s, cervical cancer screening was being performed at hundreds of centers across the country; over the following 40 years, cervical cancer incidence and mortality decreased by 60%.[2] Screening for other types of cancer was introduced soon afterward (mammography in 1963, colonoscopy in 1969)—and the use of screening increased greatly. Although cures for many cancers remained frustratingly elusive, screening was attractive because it seemed reassuringly actionable: people could do their part, by either undergoing screening tests themselves or encouraging others to do so.

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Cancer screening in the 21st century, however, is losing its luster. Increasing evidence suggests that many modalities of cancer screening may be far less beneficial than first thought. Screenings that used to be straightforwardly recommended, such as the prostate-specific antigen test, are now discouraged by many experts. Emerging mammography data show