American Journal of
Preventive Medicine

RESEARCH BRIEF

Lung Cancer Screening Utilization: A Behavioral Risk Factor Surveillance System Analysis

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Introduction: Lung cancer is the leading cause of cancer-related death in the U.S. The National Lung Screening Trial found that low-dose computed tomography reduced lung cancer mortality in high-risk individuals. As a result, the U.S. Preventive Services Task Force began recommending low-dose computed tomography screening for those at a high risk in 2013. Therefore, it is imperative to continually monitor lung cancer screening uptake. The objective of this study was to determine computed tomography screening uptake across ten states using 2017 Behavioral Risk Factor Surveillance System survey data.

Methods: In fall 2018, a cross-sectional analysis was performed on survey data from 4,374 low-dose computed tomography–eligible participants, as determined by Task Force recommendations. Weighted percentages were calculated to assess computed tomography screening utilization overall and by state, sociodemographic, and clinical characteristics; Wald chi-squared tests evaluated group differences.

Results: Within the study sample, 14.4% of eligible individuals had a computed tomography scan to test for lung cancer within the past 12 months. Significant state-to-state variation was identified (6.5% utilization in Nevada to 18.1% in Florida, p=0.03). Screening utilization was higher among individuals with insurance than among the uninsured (15.2% vs 4.0%, p<0.001), and it was higher among individuals with asthma (22.9% vs 12.9%, p=0.006) or chronic obstructive pulmonary disease (23.7% vs 8.5%, p<0.001) than among those without either condition.

Conclusions: Computed tomography screening utilization was higher than in earlier estimates. However, further research is needed to elucidate geographic variation in screening.
Am J Prev Med 2019;57(2):250–255.

INTRODUCTION

Lung cancer is the leading cause of cancer-related death in the U.S.[1] The National Lung Cancer Screening Trial found that annual low-dose computed tomography (LDCT) screening for lung cancer in high-risk populations resulted in a 20% relative reduction in lung cancer mortality.[2] Subsequently, in 2013, the U.S. Preventive Services Task Force began to recommend annual LDCT screening for high-risk populations, current or former smokers (who have quit within the past 15 years) with a 30 pack-year smoking history and who are aged 55–80 years.[3] This recommendation was the impetus for several federal policy changes facilitating public and private insurance coverage for LDCT screening for eligible individuals.[4,5] As LDCT screening for lung cancer is only newly recommended, population-level assessments of uptake are limited. A recent study using 2010 and 2015 data from the National Health Interview Survey (NHIS) found that only 3.3% and 3.9%, respectively, of screening-eligible individuals had received an LDCT screening for lung cancer.[6] The study

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0749-3797/$36.00
https://doi.org/10.1016/j.amepre.2019.03.015

objective was to use 2017 Behavioral Risk Factor Surveillance System (BRFSS) survey data to determine uptake of computed tomography (CT) screening across the ten states that included the optional lung cancer screening module.

METHODS

Study Sample

Data from the Centers for Disease Control and Prevention's 2017 BRFSS survey were used in this analysis. BRFSS is an ongoing, population-based telephone survey conducted across states and participating territories that collects information on health-related risk behavior, chronic disease prevalence, and use of preventive services among the noninstitutionalized adult population.[7,8] Design weights and a raking weighting methodology were used to account for land and cellular phone lines and demographic characteristics of the study sample to ensure that the sample properly represents the sociodemographic composition of the state.[7]

Measures

In addition to the BRFSS core component questions, states can include optional modules that focus on a specific risk factor,

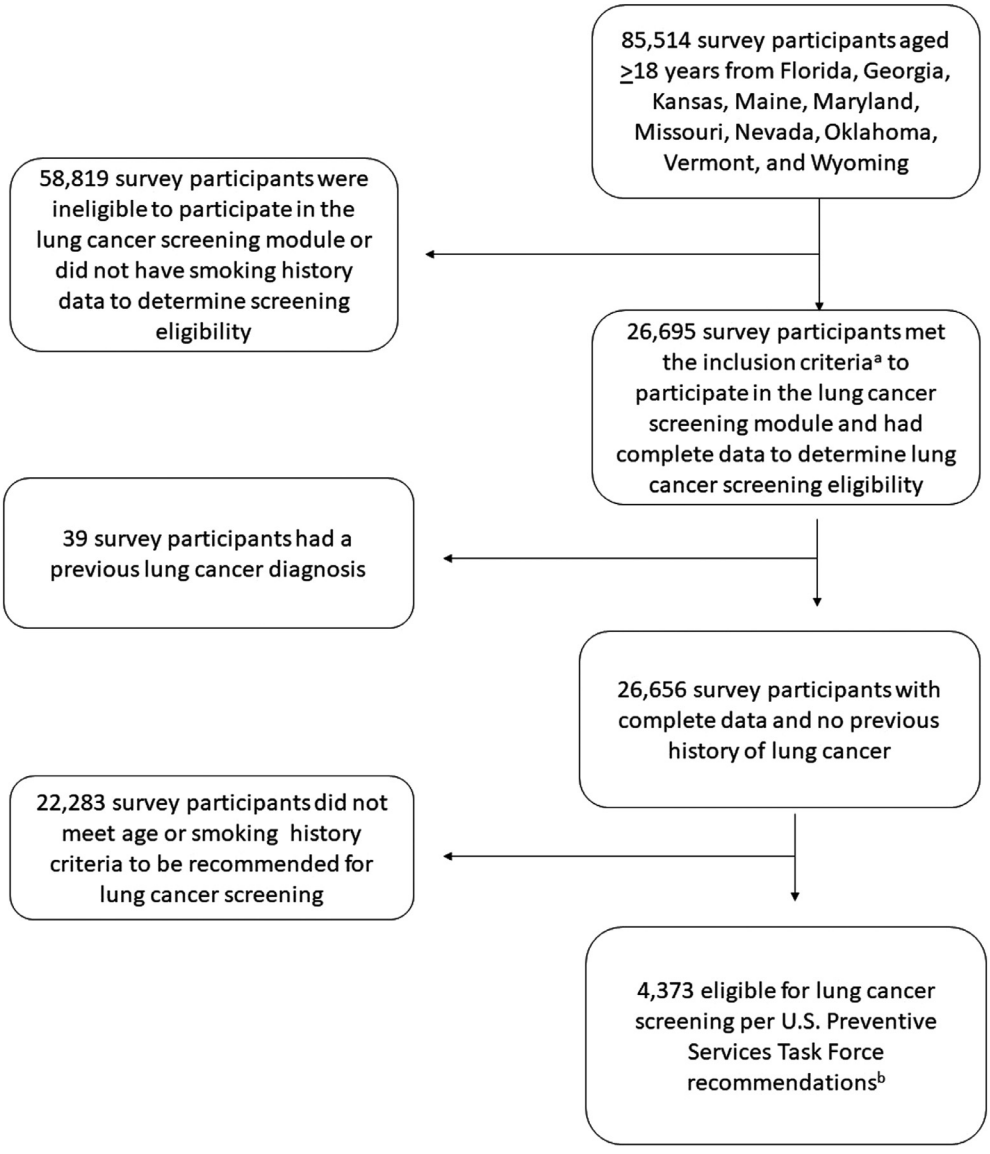

Figure 1. Sample selection flow diagram.

Note: Complete data indicate participants provided sufficient answers (i.e., no missing data, refusals to answer, or *don't know/not sure* responses to relevant questions) to determine pack-year smoking history, current smoking status, and age to enable the determination of screening eligibility.

[a]Inclusion criteria included the participant indicating they had smoked at least 100 cigarettes in their life and provided an answer of *every day*, *some days*, or *not at all* to a question about current smoking status.

[b]U.S. Preventive Services Task Force recommendations for lung cancer screening are those aged 55–80 years who currently smoke or have quit smoking in the past 15 years and have at least a 30 pack-year history of smoking.

Table 1. CT Screening Uptake Within the Past 12 Months Among Eligible 2017 BRFSS Participants[a]

	All eligible BRFSS participants		Had a CT scan to check for lung cancer in the past 12 months		Did not have a CT scan to check for lung cancer in the past 12 months		
Variable	***n***	**% (95% CI)**	***n***	**% (95% CI)**	***n***	**% (95% CI)**	**Wald *p*-value[b]**
All	4,373	100.0 (–)	621	14.4 (12.3, 16.5)	3,752	85.6 (83.5, 87.7)	—
Sex							0.64
Male	2,326	58.6 (55.9, 61.3)	333	14.8 (12.1, 17.5)	1,993	85.2 (82.4, 88.0)	
Female	2,047	41.4 (38.7, 44.1)	288	13.8 (10.9, 16.8)	1,759	86.2 (83.2, 89.1)	
Marital status (missing *n*=15)							0.33
Married	1,886	47.9 (45.1, 50.8)	239	12.1 (9.8, 14.4)	1,647	87.9 (85.5, 90.3)	
Divorced	1,187	24.4 (22.1, 26.6)	175	16.4 (12.4, 20.3)	1,012	85.6 (79.3, 87.9)	
Widowed	862	16.7 (14.7, 18.6)	138	17.5 (14.1, 20.9)	724	82.5 (76.8, 88.2)	
Separated	97	2.9 (1.6, 4.1)	12	21.9 (17.6, 26.2)	85	78.1 (51.2, 100.0)	
Never married	237	5.5 (4.2, 6.7)	37	11.0 (7.5, 14.6)	200	89.0 (82.9, 95.0)	
A member of an unmarried couple	90	2.7 (1.8, 3.6)	15	16.1 (11.2, 21.1)	75	83.9 (70.0, 97.7)	
Educational status (missing *n*=6)							0.75
Less than high school education	501	17.0 (14.6, 19.3)	66	15.5 (11.1, 20.0)	435	84.5 (77.2, 91.8)	
High school educated	1,633	35.9 (33.1, 38.7)	232	13.5 (11.3, 15.7)	1,401	86.5 (83.5, 89.5)	
Some college	1,434	33.9 (31.1, 36.6)	200	13.9 (11.4, 16.5)	1,234	86.1 (83.0, 89.2)	
College educated	799	13.2 (11.6, 14.9)	122	16.9 (11.5, 22.3)	677	83.1 (77.4, 88.8)	
Race/Ethnicity (missing *n*=1)							0.33
White, non-Hispanic	3,309	86.6 (94.1, 89.0)	559	14.8 (12.7, 16.9)	3,350	85.2 (83.0, 87.3)	
Black, non-Hispanic	149	6.2 (4.0, 8.4)	17	12.6 (8.6, 16.5)	132	87.4 (73.1, 100.0)	
Hispanic	73	2.5 (1.5, 3.4)	6	7.5 (6.3, 8.8)	67	92.5 (85.5, 99.5)	
Non-Hispanic Asian, American Indian, Alaska Native, or other race	242	4.7 (3.5, 6.0)	39	12.4 (7.9, 16.9)	203	87.6 (81.7, 93.5)	
Age, years							0.06
55–64	2,046	50.4 (55.9, 61.3)	244	12.4 (9.9, 14.8)	1,802	87.6 (85.1, 90.1)	
65–80	2,327	49.6 (38.7, 44.1)	377	16.5 (13.2, 19.8)	1,950	83.5 (80.2, 86.9)	
Insurance coverage (missing *n*=15)							**<0.001**
Yes	4,041	92.8 (91.4, 94.2)	601	15.2 (13.0, 17.4)	3,440	84.8 (82.6, 87.0)	
No	318	7.2 (5.8, 8.6)	16	4.0 (1.2, 6.7)	302	96.0 (93.3, 98.8)	
Veteran status (missing *n*=3)							0.38
Yes	1,162	27.4 (24.9, 29.9)	173	16.0 (12.7, 19.4)	989	84.0 (79.9, 88.0)	
No	3,209	72.6 (70.1, 75.1)	448	13.8 (11.4, 16.2)	2,761	86.2 (83.7, 88.7)	

(*continued on next page*)

Table 1. CT Screening Uptake Within the Past 12 Months Among Eligible 2017 BRFSS Participants[a] (*continued*)

Variable	All eligible BRFSS participants		Had a CT scan to check for lung cancer in the past 12 months		Did not have a CT scan to check for lung cancer in the past 12 months		Wald *p*-value[b]
	n	% (95% CI)	*n*	% (95% CI)	*n*	% (95% CI)	
Ever been diagnosed with asthma? (missing *n*=14)							**0.006**
Yes	686	15.5 (13.6, 17.5)	146	22.9 (17.4, 28.4)	540	77.1 (70.6, 83.6)	
No	3,674	84.5 (82.5, 86.4)	475	12.9 (10.8, 15.0)	3,199	87.1 (85.0, 89.2)	
Ever been diagnosed with COPD? (missing *n*=19)							**<0.001**
Yes	1,676	36.5 (33.8, 39.1)	377	23.7 (20.2, 27.3)	1,299	76.3 (72.4, 80.1)	
No	2,669	63.5 (60.9, 66.2)	242	8.5 (6.6, 10.4)	2,427	91.5 (89.6, 93.4)	
Smoking status							0.59
Current smoker, ≥30 pack-year history	1,915	47.5 (44.7, 50.2)	256	13.8 (10.8, 16.8)	1,659	86.2 (84.5, 89.4)	
Former smoker, ≥30 pack-year history, quit <15 years ago	2,458	52.5 (49.8, 55.3)	365	15.0 (12.1, 17.8)	2,093	85.0 (82.2, 87.9)	

[a]Percentages are weighted.
[b]Bolded values indicate statistically significant differences between CT scan uptake categories, with a *p*-value set at 0.05.
BRFSS, Behavioral Risk Factor Surveillance System; COPD, chronic obstructive pulmonary disease; CT, computed tomography.

disease, or service. In 2017, an optional module focused on lung cancer screening was selected by ten states (Florida, Georgia, Kansas, Maine, Maryland, Missouri, Nevada, Oklahoma, Vermont, and Wyoming), representing 17.2% of the U.S. population.[9] This module was administered to those who smoked at least 100 cigarettes in their lifetime and included four questions about age at smoking initiation, age when the survey participant last smoked regularly, average number of cigarettes smoked per day, and whether they had a CT scan in the past year. The CT scan question was worded as follows: *[t]he next question is about CT or CAT scans. During this test, you lie flat on your back on a table. While you hold your breath, the table moves through a donut shaped x-ray machine while the scan is done. In the last 12 months, did you have a CT or CAT scan?*" Answer options were *yes to check for lung cancer*, *no*, and *yes for other reasons*. For this analysis, this screening variable was collapsed to assess receipt of a CT scan to check for lung cancer compared with nonreceipt of a CT scan to test for lung cancer.

Screening eligibility was determined per U.S. Preventive Services Task Force recommendations using the lung cancer module and standard core component questions. Current age of the survey participant, age when the survey participant last smoked, and current smoking status were drawn from the standard core component questions. Smoking history was ascertained by subtracting the age of smoking initiation from the age when the survey participant indicated that they last smoked regularly. The participant's pack-year history was calculated by dividing the number of cigarettes smoked daily by 20 to determine packs per day, which was then multiplied by the number of years the participant smoked. Those who were ineligible for LDCT screening, whose eligibility for LDCT screening could not be determined owing to incomplete data, or who had a previous lung cancer diagnosis were excluded (Figure 1).

Statistical Analysis

Weighted percentages and corresponding 95% CIs were calculated to describe the sociodemographic characteristics of survey participants eligible for screening overall and by screening utilization. Wald's design-based chi-squared tests of independence analyses were performed to test for differences in CT screening by sociodemographic characteristics and geography. All analyses were performed in fall 2018 using appropriate procedures to account for BRFSS complex survey design in SAS, version 9.4. Findings are reported without corrections for multiple comparisons as such adjustments can lead to errors in interpretation in observational studies.[10]

RESULTS

The study sample included 4,373 LDCT-eligible survey participants. Among these, 14.4% had a CT scan to check for lung cancer within the past 12 months. Screening among LDCT-eligible individuals varied by sociodemographic characteristic (Table 1). The proportion of individuals who utilized CT screening for lung cancer was higher among insured individuals than among uninsured individuals (15.2% vs 4.0%, $p<0.001$). Among

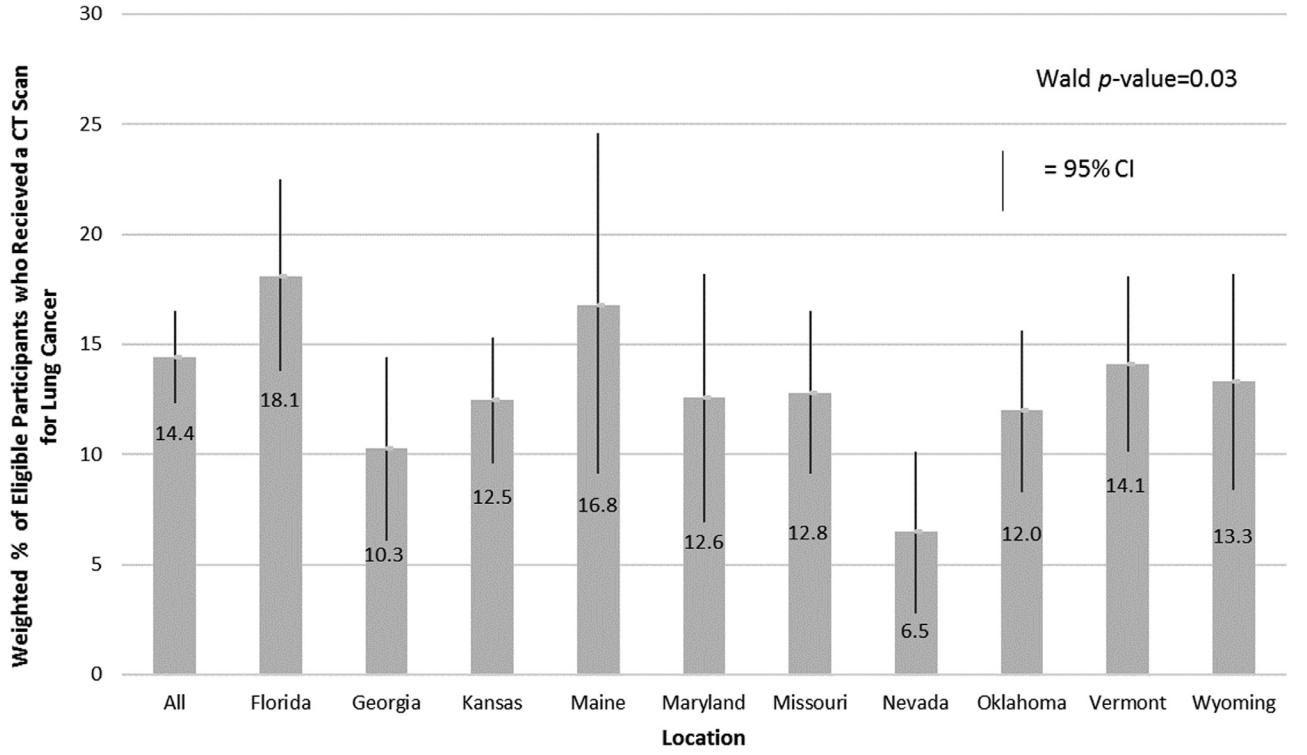

Figure 2. Uptake of lung cancer screening by state, 2017 BRFSS.
BRFSS, Behavioral Risk Factor Surveillance System; CT, computed tomography.

those with asthma, 22.9% had been screened versus 12.9% of those without asthma (p=0.006). Similarly, a higher proportion of those with chronic obstructive pulmonary disease (23.7%) had been screened than those without chronic obstructive pulmonary disease (8.5%, p<0.001). Significant state-to-state variation in screening was observed, ranging from 6.5% of eligible individuals in Nevada to 18.1% in Florida (p=0.03) (Figure 2).

DISCUSSION

These findings describe the CT screening utilization across ten states and among different sociodemographic groups in 2017. Though the 2015 NHIS was representative of the entire U.S. population and utilized different sampling schemes than the 2017 BRFSS, the rate of participation in CT screening in the BRFSS was 10 percentage points higher than previously reported nationally in the 2015 NHIS.[6,7,11] When the 2015 NHIS survey was being deployed, insurance coverage policies for lung cancer screening were in flux. With nearly all insurance plans now covering LDCT screening for lung cancer,[4,5] a rise in screening utilization was anticipated. The aggregated 2010 and 2015 NHIS showed no differences in utilization by insurance status.[6] However, with the initiation and implementation of Medicare and Affordable Care Act–associated reimbursement, the utilization rate among those with insurance was higher among 2017 BRFSS survey participants than among 2015 NHIS survey participants. Additionally, unlike earlier NHIS analysis, the 2017 BRFSS survey showed higher screening rates among the insured than among the uninsured.

Utilization of CT screening varied by state. Florida had the highest utilization rate among states that incorporated the lung cancer screening module into their 2017 BRFSS survey. Previous research estimates that Florida has the second highest proportion of residents who are LDCT-eligible, indicating that screening was most highly utilized among the surveying states in a state with a high proportion of residents eligible for screening.[12] Further, the authors found that Georgia and Nevada had the lowest utilization rates of all surveyed states despite being in the highest tertile of states for spatial access to LDCT screening centers.[13] It is possible that they may not be accessible to those who are eligible for screening (e.g., eligible individuals are disproportionately in rural areas). This hypothesis could not be explored with BRFSS data because of restrictions on accessing data on rurality. There could also be regional variations in

physician recommendations/referral for screening or cultural acceptability/stigma.

Limitations

Only ten states opted to include this lung cancer screening module, and eligible individuals in these states were less diverse and less educated than those of screening age throughout the U.S.[9] Furthermore, the lung cancer screening module did not include questions about shared decision-making conversations that patients may have had with their provider that may have influenced whether they were screened.[14] As with all self-reported phone surveys, responses are subject to recall bias, and subpopulations (e.g., low-income, rural) who have less phone access may be under-represented.

CONCLUSIONS

Because lung cancer is the leading cause of cancer death in the U.S., there is an impetus to ensure that all individuals at a high risk for lung cancer can access and receive screening. Although rates of lung cancer screening utilization were higher in the 2017 BRFSS than in earlier population-based estimates, utilization of lung cancer screening remains low. Future research should explore why rates of uptake vary by state when insurance coverage for the screening is dictated by federal policies.

ACKNOWLEDGMENTS

No financial disclosures were reported by the authors of this paper.

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