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Research Article

Cancer Epidemiology, Biomarkers & Prevention

Low Rates of Patient-Reported Physician–Patient Discussion about Lung Cancer Screening among Current Smokers: Data from Health Information National Trends Survey

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Abstract

Background: Many professional societies published guidelines recommending lung cancer screening with low-dose CT scan. We examined the temporal trends in patient-reported physician–patient discussions about lung cancer screening, and aimed to determine the association of discussions of lung cancer screening with the smokers' attempt to quit and intent to quit.

Methods: Data from years 2012, 2014, and 2017 of the National Cancer Institute's Health Information National Trends Survey (HINTS) were combined to create a multiple-year analytic dataset. We calculated the association between samples' characteristics and the presence of discussion about lung cancer screening. Using logistic regression, we estimated the probability of smokers' attempt to quit and intent to quit.

Results: Among 9,443 subjects, the crude estimated rates of physician–patient discussion decreased from 6.7% in 2012, to 4.2% in 2014 and 4.3% in 2017. Across the age and smoking status groups, the current smokers ages 55 to 74 in 2012 (26.8%), and current smokers older than 74 years in 2014 (23.5%) and 2017 (22.1%) had the highest rates of discussion. The physician–patient discussion about lung cancer screening was not associated with patients' intent to quit or attempt to quit in a multivariable analysis.

Conclusions: Efforts are needed to improve the physician–patient discussion about lung cancer screening among individuals across a spectrum of lung cancer risk.

Impact: Developing communication strategies for promoting beneficial lung cancer screening among lung cancer screening-eligible smokers and strategies for improving the quality of discussion on lung cancer screening integrating smoking cessation are needed to reduce the burden of lung cancer.

Introduction

Lung cancer is the leading cause of cancer-related death in the United States. It is estimated that 234,030 new cases of carcinoma of the lung were diagnosed in 2018, and that 154,050 patients died from this disease (1). In past decades, researchers conducted dozens of trials investigating the effectiveness of chest X-rays (CXR), sputum cytology, and computed tomography (CT) on lung cancer screening, and all failed to show a significant reduction in lung cancer–related mortality (2–6). In 2011, the National Lung Screening Trial (NLST), the largest trial ever of lung cancer screening with 53,454 current or former heavy smokers ages 55 to 74, demonstrated that low-dose computed tomography (LDCT) reduced lung cancer–related mortality by 20% compared with CXR (7). Following the release of results from the NLST, many academic and medical societies published guidelines from 2011 to 2015 recommending LDCT for individuals at high risk for lung cancer (8–14). Although age eligibility criteria for lung cancer screening with LDCT differ slightly across guidelines and recommendations, all acknowledged the efficacy of LDCT as a screening modality for lung cancer control.

Availability of lung cancer screening with LDCT offers a critical and teachable moment to provide smoking cessation counseling for current smokers. However, conflicting findings on the effects of lung cancer screening on smoking behavior modification have been reported in both randomized trials and non-randomized studies. The Dutch-Belgian screening study (NELSON) and the Danish Lung Cancer Screening Trial (DLCST) reported no significant changes in the smoking behavior between participants who received screening and those who received no screening (15). On the other hand, the recent UK Lung Cancer Screening (UKLS) Pilot Trial of low-dose CT screening found that individuals who received lung cancer screening were significantly more likely to quit smoking in the long term (16). Given these contradictory findings, estimates of the association of physician–patient discussion about lung cancer screening and motivation to quit smoking on a national level could inform policymakers and practitioners alike on integrating a smoking cessation program effectively into the promising lung cancer screening practice.

To address gaps in knowledge regarding the impact of the national guidelines and recommendations on lung cancer screening, we used data from a nationally representative sample of US adults to analyze the contemporary patterns in physician–patient discussion about this promising screening technique. Our primary

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objective was to ascertain the temporal trends in physician–patient discussion about lung cancer screening after the introduction of NLST results in 2011, the USPSTF final recommendation on lung cancer screening in 2013, and the CMS Medicare Coverage policy on lung cancer screening in 2015. Secondarily, we determined whether the pattern of physician–patient discussion differed by age group, smoking status, insurance coverage, and ethnicity over the study period from 2012 to 2017. We also examined the rates of physician–patient discussion about lung cancer screening among the screening eligible and ineligible population. Finally, we examined the association between patient-reported physician–patient discussion (referred to hereafter as physician–patient discussion) about lung cancer screening and the smokers' attempt to quit and intent to quit.

Materials and Methods

Data

This study was based on data acquired from the National Cancer Institute's Health Information National Trends Survey (HINTS) data, a nationwide and population-based cross-sectional computer-assisted telephone interview survey that collects cancer-related information on health technology and communication. Because HINTS survey is not conducted every year, we included three most recent surveys after release of NLST results: HINTS 5 Cycle 1 (2017), HINTS 4 Cycle 4 (2014), and HINTS 4 Cycle 2 (2012) datasets. The target population of HINTS is adults of age 18 or older in the civilian non-institutionalized population of the United States.

Study population

As an outcome of interest in the study was the presence of discussion between providers and patients about lung cancer screening, our sample was restricted to the adult population, age 18 and older, with a certain answer (either Yes or No) to the HINTS question "Past year, have you talked with your doctor about having a test to check for lung cancer?" (Study sample excluded because of missing value for this question: $N = 558$). Because both the USPSTF recommendation statement on lung cancer screening and the Medicare Coverage Decision Memo for Screening for Lung Cancer with LDCT indicate age and smoking history are the most critical eligibility criteria for lung cancer screening, analyses were further restricted to adults who had no missing value in the age variable (missing: $N = 527$) and had identifiable smoking status (missing: $N = 34$).

Baseline measurements

Several smoking behavior questions were asked in the HINTS survey, and we used two of them to define the current smoking status. However, because pack-year history was not collected in the HINTS survey, we stratified the study individuals into three groups based on the current smoking status: never smokers, former smokers, and current smokers. The samples were asked, "Have you smoked at least 100 cigarettes in your entire life?" and "How often do you now smoke cigarettes?" Ever smokers were defined as those who have smoked at least 100 cigarettes in their entire life. Current smokers were defined as those who were ever smokers and still smoked cigarettes every day or somedays. Former smokers were defined as those who were ever smokers and did not smoke cigarettes at the time of survey interview. Never smokers were defined as those who had none or less than 100 cigarettes smoked during their lifetime.

Two survey questions were used to measure the modification on smokers' behavior: smokers' intent to quit smoking was identified by the question "Are you seriously considering quitting smoking in the next six months?" Smokers' attempt to quit was identified by the question "At any time in the past year, have you stopped smoking for one day or longer?" The baseline demographic and socioeconomic characteristics recorded in the HINTS survey includes sex, age, race/ethnicity, education, marital status, family income, employment, insurance coverage, and census region. Because the CMS Medicare Coverage Policy on lung cancer screening defined the age eligibility criteria from 55 to 77, we classified the sample into three age groups, <55, 55–77, and 78 years or older.

Statistical analysis

Data from years 2012, 2014, and 2017 of the HINTS were combined to create a multiple-year analytic dataset. Our analytic process involved two steps. In step one, we assessed whether the demographics and health-related characteristics of survey samples differed by the presence of physician–patient discussion about lung cancer screening using the Pearson χ^2 test. We generated prevalence of physician–patient discussion by three age groups, smoking status, and race/ethnicity groups with weighted proportions and 95% confidence intervals (CIs). We used the Cochran–Armitage test to examine the trend. In the second step, to examine the factors associated with a physician–patient discussion about lung cancer screening among study samples and the association between physician–patient discussion and modification of smoking behavior, we used a multivariable logistic model that controlled for statistically significant or clinically meaningful characteristics.

We conducted data analysis using the SAS version 9.4 (Cary, NC). Sampling weights based on the HINTS complex sample design were used in the statistical analysis. We used SURVEYMEANS procedure to derive nationally representative estimates and to generate standard errors, and SURVEYLOGISTIC procedure for the multivariable logistic model. Statistical significance of the test was defined as a P value of less than 0.05. This study was approved as exempt by the institutional review board at the University of Florida.

Results

Our sample consisted of 9,443 individuals (weighted sample size: 656,755,792) from HINTS data. Table 1 presents the distribution of the study population and presence of physician–patient discussion about lung cancer screening in relation to the sample's demographic and health-related characteristics over three waves of survey interviews in 2012, 2014, and 2017. The study sample includes 54% who were 55 years and older, 57% were women, and 58% were non-Hispanic white.

Physician–patient discussions

The findings of the prevalence of physician–patient discussion about lung cancer screening by year of survey, age group, smoking status, and racial/ethnicity groups appear in Figs. 1 and 2. The crude estimates rate of physician–patient discussion were 6.7% in 2012, 4.2% in 2014 and 4.3% in 2017 ($P = 0.002$; Fig. 1A), and current smokers had higher rates of physician–patient discussion

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Table 1. Baseline information of U.S. adults: HINTS 2012, 2014, and 2017, population estimates percentage (95% CI)

	Screening consultation for lung cancer											
	2012				2014				2017			
Characteristics	***N***	**Yes**	**No**	***P***	***N***	**Yes**	**No**	***P***	***N***	**Yes**	**No**	***P***
Demographics												
Age group				<0.0001				<0.0001				<0.0001
18–54	1,636	3.6 (2.4–4.7)	96.4 (95.3–97.6)		1,475	2.6 (1.3–3.9)	97.4 (96.1–98.7)		1,219	2.0 (1.0–3.0)	98.0 (97.0–99.0)	
55–77	1,322	12.2 (9.7–14.7)	87.8 (85.3–90.3)		1,522	7.2 (5.5–8.9)	92.8 (91.1–94.5)		1,502	8.0 (6.3–9.7)	92.0 (90.3–93.7)	
78+	263	17.0 (9.7–24.3)	83.0 (75.7–90.3)		274	7.3 (4.0–10.5)	92.7 (89.5–96.0)		230	10.4 (5.5–15.4)	89.6 (84.6–94.5)	
Smoking status				<0.0001				0.005				0.0001
Current	538	12.0 (8.8–15.3)	88.0 (84.7–91.2)		445	8.4 (5.2–11.6)	91.6 (88.4–94.8)		380	8.7 (5.9–11.5)	91.3 (88.5–94.1)	
Former	824	9.1 (6.3–11.9)	90.9 (88.1–93.7)		870	5.5 (3.8–7.2)	94.5 (92.8–96.2)		788	7.3 (4.8–9.9)	92.7 (90.1–95.2)	
Never	1,859	4.0 (2.5–5.5)	96.0 (94.5–97.5)		1,956	2.6 (1.3–3.9)	97.4 (96.1–98.7)		1,783	2.1 (1.4–2.9)	97.9 (97.1–98.6)	
Sex				0.246				0.989				0.152
Male	1,268	7.3 (5.2–9.4)	92.7 (90.6–94.8)		1,263	4.1 (2.6–5.5)	95.9 (94.5–97.4)		1,163	5.1 (3.4–6.7)	94.9 (93.3–96.6)	
Female	1,828	5.6 (4.0–7.2)	94.4 (92.8–96.0)		1,866	4.1 (2.7–5.5)	95.9 (94.5–97.3)		1,653	3.4 (2.5–4.3)	96.6 (95.7–97.5)	
Race/ethnicity				0.778				0.047				0.199
Non-Hispanic white	1,890	6.0 (4.5–7.5)	94.0 (92.5–95.5)		1,844	2.4 (1.6–3.2)	97.6 (96.8–98.4)		1,764	4.4 (3.1–5.8)	95.6 (94.2–96.9)	
Non-Hispanic black	438	7.1 (4.5–9.8)	92.9 (90.2–95.5)		488	7.1 (2.9–11.3)	92.9 (88.7–97.1)		376	5.0 (2.3–7.8)	95.0 (92.2–97.7)	
Hispanic	456	6.4 (3.8–8.9)	93.6 (91.1–96.2)		482	5.4 (1.7–9.2)	94.6 (90.8–98.3)		384	2.6 (1.0–4.2)	97.4 (95.8–99.0)	
Other	197	4.9 (0.8–8.9)	95.1 (91.1–99.2)		216	3.7 (0.0–7.6)	96.3 (92.4–100)		227	3.6 (1.2–6.0)	96.4 (94.0–98.8)	
Education				0.019				0.209				0.129
Less than high school	275	12.8 (7.8–17.7)	87.2 (82.3–92.2)		276	9.5 (5.0–14)	90.5 (86.0–95.0)		190	6.4 (2.9–9.9)	93.6 (90.1–97.1)	
High school graduate	686	7.4 (4.9–9.8)	92.6 (90.2–95.1)		603	4.1 (2.0–6.3)	95.9 (93.7–98.0)		553	5.4 (3.3–7.5)	94.6 (92.5–96.7)	
Some college	953	6.8 (4.5–9.1)	93.2 (90.9–95.5)		991	2.8 (1.0.6–4)	97.2 (96.0–98.4)		867	4.5 (2.9–6.0)	95.5 (94.0–97.1)	
College or higher	1,288	3.5 (2.3–4.8)	96.5 (95.2–97.7)		1,380	3.6 (1.9–5.3)	96.4 (94.7–98.1)		1,326	3.0 (1.8–4.3)	97.0 (95.7–98.2)	
Marital status				0.002				0.005				0.016
Single	620	4.5 (2.1–6.9)	95.5 (93.1–97.9)		588	3.3 (1.3–5.3)	96.7 (94.7–98.7)		500	2.8 (1.5–4.0)	97.2 (96.0–98.5)	
Divorced/widowed/separated	918	11.5 (8.3–14.7)	88.5 (85.3–91.7)		1,006	8.7 (5.7–11.7)	91.3 (88.3–94.3)		818	6.3 (4.1–8.5)	93.7 (91.5–95.9)	
Married	1,683	6.5 (5.1–7.9)	93.5 (92.1–94.9)		1,677	3.4 (2.2–4.6)	96.6 (95.4–97.8)		1,633	4.7 (3.1–6.3)	95.3 (93.7–96.9)	
Family Income				0.172				0.010				0.458
Less than $20,000	646	9.8 (6.8–12.9)	90.2 (87.1–93.2)		662	7.1 (4.7–9.4)	92.9 (90.6–95.3)		481	5.1 (3.3–6.9)	94.9 (93.1–96.7)	
$20,000 to < $35,000	442	8.2 (4.1–12.2)	91.8 (87.8–95.9)		446	5.9 (1.5–10.3)	94.1 (89.8–98.5)		379	6.1 (2.7–9.6)	93.9 (90.4–97.3)	
$35,000 to < $50,000	409	4.3 (2.2–6.5)	95.7 (93.5–97.8)		434	1.8 (0.8–2.8)	98.2 (97.2–99.2)		353	4.3 (1.9–6.7)	95.7 (93.3–98.1)	
$50,000 to < $75,000	497	5.3 (3.2–7.4)	94.7 (92.6–96.8)		509	3.7 (1.0–6.3)	96.3 (93.7–99.0)		491	3.8 (1.5–6.2)	96.2 (93.8–98.5)	
$75,000 or More	857	5.0 (2.3–7.6)	95.0 (92.4–97.7)		918	2.8 (1.1–4.6)	97.2 (95.4–98.9)		996	3.5 (2.2–4.8)	96.5 (95.2–97.8)	
Employment				0.001				0.064				<0.0001
Employed	1,691	4.6 (3.0–6.1)	95.5 (93.9–97.0)		1,663	2.9 (1.5–4.3)	97.1 (95.7–98.5)		1,507	2.9 (1.8–4.0)	97.1 (96.0–98.2)	
Not employed	1,524	9.4 (7.3–11.6)	90.6 (88.4–92.7)		1,603	6.0 (4.6–7.5)	94.0 (92.5–95.4)		1,437	6.3 (4.9–7.7)	93.7 (92.3–95.1)	
Census Region				0.075				0.107				0.574
Northeast	487	9.8 (5.9–13.8)	90.2 (86.2–94.1)		512	5.6 (2.3–8.8)	94.4 (91.2–97.7)		474	5.1 (2.6–7.6)	94.9 (92.4–97.4)	
Midwest	620	6.1 (3.5–8.8)	93.9 (91.2–96.5)		623	3.6 (1.5–5.6)	96.4 (94.4–98.5)		558	3.9 (1.8–6.1)	96.1 (93.9–98.2)	
South	1,361	6.9 (5.0–8.8)	93.1 (91.2–95.0)		1,382	4.1 (2.9–5.3)	95.9 (94.7–97.1)		1,243	4.5 (3.0–6.1)	95.5 (93.9–97.0)	
West	753	4.3 (3.0–5.6)	95.7 (94.4–97.0)		754	3.7 (1.3–6.2)	96.3 (93.8–98.7)		676	3.8 (2.4–5.3)	96.2 (94.7–97.6)	
Health characteristics												
Health Insurance				<0.0001				0.793				0.259
Yes	2,685	7.5 (6.1–9.0)	92.5 (91.0–93.9)		2,860	3.9 (2.8–5.0)	96.1 (95.0–97.2)		2,794	4.4 (3.4–5.3)	95.6 (94.7–96.6)	
No	509	2.8 (0.9–4.8)	97.2 (95.2–99.1)		363	4.4 (0.3–8.5)	95.6 (91.5–99.7)		133	3.7 (0.0–7.8)	96.3 (92.2–100.0)	

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Table 1. Baseline information of U.S. adults: HINTS 2012, 2014, and 2017, population estimates percentage (95% CI) (Cont'd)

	Screening consultation for lung cancer											
	2012				2014				2017			
Characteristics	***N***	**Yes**	**No**	***P***	***N***	**Yes**	**No**	***P***	***N***	**Yes**	**No**	***P***
General Health				<0.0001				0.023				0.051
Excellent	346	1.3 (0.2–2.3)	98.7 (97.7–99.8)		346	4.4 (0.5–8.3)	95.6 (91.7–99.5)		335	3.8 (0.0–7.7)	96.2 (92.3–100.0)	
Very good	1,110	5.4 (3.5–7.4)	94.6 (92.6–96.5)		1,089	3.5 (1.8–5.3)	96.5 (94.7–98.2)		1,075	3.0 (2.0–3.9)	97.0 (96.1–98.0)	
Good	1,147	7.2 (5.2–9.1)	92.8 (90.9–94.8)		1,218	3.8 (2.3–5.2)	96.2 (94.8–97.7)		1,014	4.6 (3.1–6.2)	95.4 (93.8–96.9)	
Fair	431	11.2 (7.1–15.2)	88.8 (84.8–92.9)		425	6.3 (3.3–9.2)	93.7 (90.8–96.7)		439	6.6 (3.8–9.3)	93.4 (90.7–96.2)	
Poor	104	16.0 (5.2–26.7)	84.0 (73.3–94.8)		110	10.1 (4.9–15.4)	89.9 (84.6–95.1)		68	8.3 (0.0–17.0)	91.7 (83.0–100.0)	
Considering quitting smoking in the next 6 months				0.174				0.549				0.207
Yes	364	13.8 (8.9–18.6)	86.2 (81.4–91.1)		283	9.1 (4.5–13.7)	90.9 (86.3–95.5)		237	10.1 (6.2–14.0)	89.9 (86.0–93.8)	
No	168	8.7 (3.9–13.5)	91.3 (86.5–96.1)		157	7.4 (2.7–12.1)	92.6 (87.9–97.3)		135	6.2 (1.4–11.0)	93.8 (89.0–98.6)	
Stopped smoking for one day or longer				0.012				0.254				0.411
Yes	513	13.3 (9.4–17.3)	86.7 (82.7–90.6)		275	9.9 (5.0–14.8)	90.1 (85.2–95.0)		235	9.7 (5.8–13.6)	90.3 (86.4–94.2)	
No	690	7.8 (5.5–10.0)	92.2 (90.0–94.5)		169	6.4 (2.3–10.4)	93.6 (89.6–97.7)		144	7.0 (2.4–11.7)	93.0 (88.3–97.6)	
Diagnosed with cancer other than lung cancer				0.001				0.002				0.004
Yes	403	16.5 (11.4–21.6)	83.5 (78.4–88.6)		447	12.0 (7.5–16.5)	88.0 (83.5–92.5)		430	10.5 (6.8–14.1)	89.5 (85.9–93.2)	
No	2,818	5.8 (4.6–7.1)	94.2 (92.9–95.4)		2,824	3.5 (2.5–4.5)	96.5 (95.5–97.5)		2,521	3.8 (2.8–4.8)	96.2 (95.2–97.2)	
Diagnosed with lung cancer				0.111				0.043				0.068
Yes	13	32.5 (0–72.8)	67.5 (27.2–100.0)		12	19.8 (0.0–47.0)	80.2 (53.0–100.0)		11	61.6 (19.5–100.0)	38.4 (0.0–80.5)	
No	3,197	6.6 (5.3–7.8)	93.4 (92.2–94.7)		3,235	4.1 (3.1–5.2)	95.9 (94.8–96.9)		2,930	4.2 (3.3–5.1)	95.8 (94.9–96.7)	
Family history of any cancer				0.213				0.832				0.187
Yes	198	7.3 (5.6–9.0)	92.7 (91.0–94.4)		2,263	4.3 (3.1–5.5)	95.7 (94.5–96.9)		2,101	4.8 (3.6–6.1)	95.2 (93.9–96.4)	
No	58	5.3 (3.1–7.6)	94.7 (92.4–96.9)		815	3.9 (1.9–5.9)	96.1 (94.1–98.1)		685	3.0 (1.8–4.2)	97.0 (95.8–98.2)	
Not sure	20	4.8 (1.5–8.2)	95.2 (91.8–98.5)		161	4.3 (0.0–9.1)	95.7 (90.9–100)		144	3.7 (0.6–6.9)	96.3 (93.1–99.4)	
Comorbid conditions												
Diabetes				0.001				0.127				0.002
Yes	573	12.7 (9.1–16.2)	87.3 (83.8–90.9)		606	7.4 (4.4–10.4)	92.6 (89.6–95.6)		569	10.3 (5.8–14.8)	89.7 (85.2–94.2)	
No	2,548	5.6 (4.3–6.9)	94.4 (93.1–95.7)		2,575	3.6 (2.4–4.8)	96.4 (95.2–97.6)		2,338	2.9 (2.2–3.7)	97.1 (96.3–97.8)	
High blood pressure				<0.0001				0.075				<0.0001
Yes	1,319	11.6 (8.9–14.4)	88.4 (85.6–91.1)		1,419	5.3 (4.0–6.6)	94.7 (93.4–96.0)		1,303	7.8 (5.6–10.0)	92.2 (90.0–94.4)	
No	1,815	4.0 (2.8–5.2)	96.0 (94.8–97.2)		1,779	3.6 (2.2–5.0)	96.4 (95.0–97.8)		1,603	2.0 (1.4–2.6)	98.0 (97.4–98.6)	
Heart disease				<0.0001				0.018				0.008
Yes	322	19.2 (13.2–25.1)	80.8 (74.9–86.8)		323	7.5 (3.6–11.4)	92.5 (88.6–96.4)		283	10.5 (5.2–15.9)	89.5 (84.1–94.8)	
No	2,812	5.6 (4.5–6.8)	94.4 (93.2–95.5)		2,867	3.9 (2.8–5.0)	96.1 (95.0–97.2)		2,633	3.7 (2.8–4.7)	96.3 (95.3–97.2)	
Lung disease				0.001				0.015				0.0003
Yes	448	15.7 (9.8–21.6)	84.3 (78.4–90.2)		422	8.2 (5.1–11.2)	91.8 (88.8–94.9)		388	11.8 (7.9–15.6)	88.2 (84.4–92.1)	
No	2,683	5.0 (3.6–6.3)	95.0 (93.7–96.4)		2,773	3.6 (2.5–4.7)	96.4 (95.3–97.5)		2,524	3.0 (2.3–3.8)	97.0 (96.2–97.7)	

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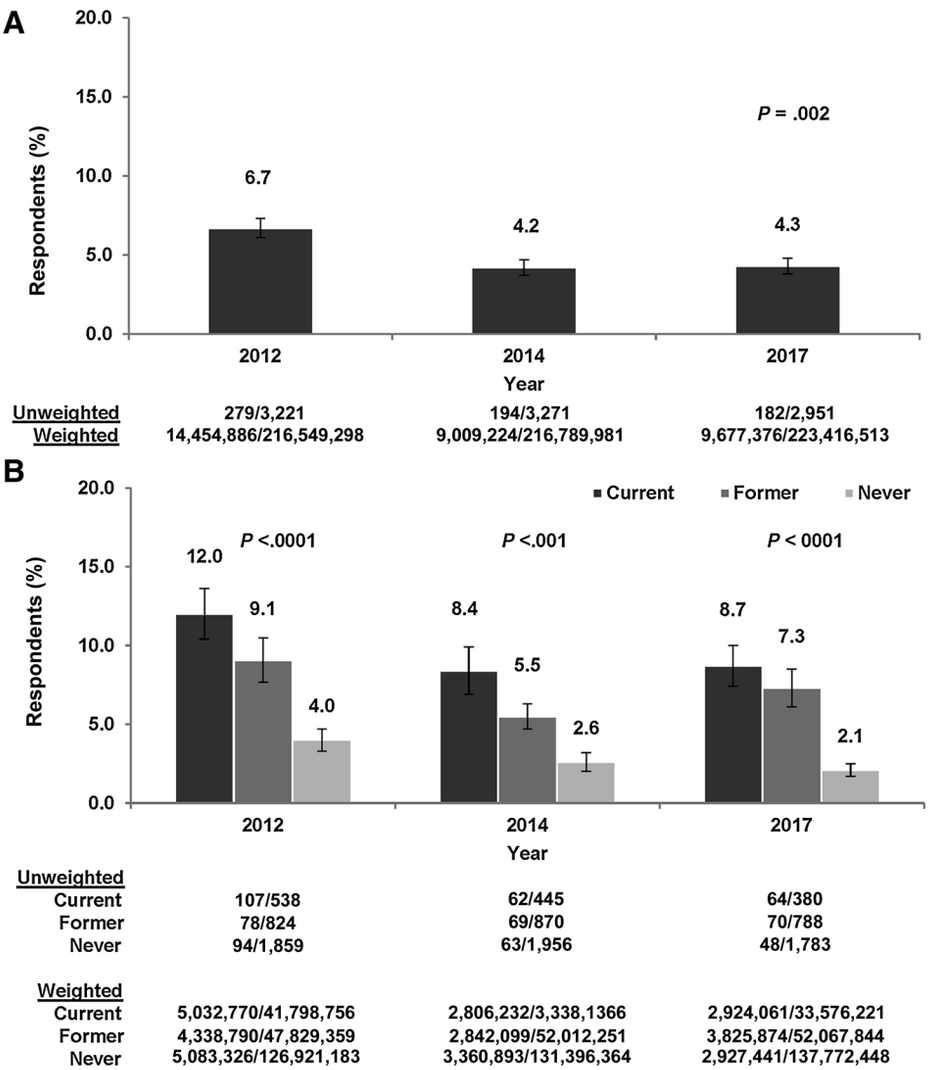

Figure 1.
The prevalence of physician–patient discussion about lung cancer screening. The prevalence of physician–patient discussion by year of survey (**A**) shows that the higher rates of physician–patient discussion about lung cancer screening in 2012 than that in 2014 and 2017. The prevalence of physician–patient discussion stratified by both year of survey and smoking status (**B**) shows that the rates of physician–patient discussion about lung cancer screening are highest among the current smokers; however, the low proportion of never smokers also had a discussion about lung cancer screening with their physicians.

than former smokers and never smokers (Fig. 1B). Across the age and smoking status groups, the current smokers ages 55 to 74 in 2012 (26.8%) and current smokers older than 74 years in 2014 (23.5%) and 2017 (22.1%) had the highest rates of physician–patient discussion (Fig. 2A–C). Whereas the samples aged less than 55 years old had lower rates, from 1.2% among never smokers ages less than 55 years old in 2017 to 7.6% among current smokers aged less than 55 years old in 2012 (Fig. 2A–C). Non-Hispanic Black was more likely to undergo a physician–patient discussion than any other race/ethnicity groups over the study period, 7.1% in 2012 and 2014, and 4.9% in 2017 (Table 1).

The results of an adjusted multivariable logistic regression on the predictors of screening discussion for lung cancer are provided in Table 2. Patients surveyed in 2014 were associated with higher odds of discussion about lung cancer screening [odds ratio (OR), 1.70; 95% CI, 1.26–2.29; $P < 0.001$] compared with those who surveyed in 2012 and 2017. Patients whose ages were older than 55 (55–77: OR, 3.25; 95% CI, 2.28–4.61; $P = 0.013$; older than 77: OR, 4.77; 95% CI, 2.76–8.27; $P < 0.0001$), current smokers (OR, 3.93; 95% CI, 2.73–5.66; $P < 0.0001$) or former smokers (OR, 1.90; 95% CI, 1.33–2.73; $P < 0.001$) were also more likely to have a discussion about lung cancer screening with their physicians. The other factors associated with increased likelihood of lung cancer screening discussion were non-Hispanic blacks, Hispanics, residents in the Northeast region, those with diagnoses of cancer other than lung, diabetes, high blood pressure, or lung diseases.

In the sensitivity analysis of a multivariable logistic regression with only current smokers (Table 3), the physician–patient discussions were significantly associated with non-Hispanic blacks (OR, 3.66; 95% CI, 2.05–6.54; $P < 0.0001$), Hispanics (OR, 3.09; 95% CI, 1.58–6.05; $P = 0.001$), patients covered by insurance (OR, 3.16; 95% CI, 1.42–7.04; $P = 0.005$), and those diagnosed with heart disease (OR, 3.23; 95% CI, 1.30–8.04; $P = 0.012$) or lung diseases (OR, 3.01, 95% CI, 1.75–5.18; $P < 0.0001$).

Intent to quit and attempt to quit

The physician–patient discussion about lung cancer screening was associated with patients' intent to quit or attempt to quit in a univariate analysis, but was insignificant in a multivariable

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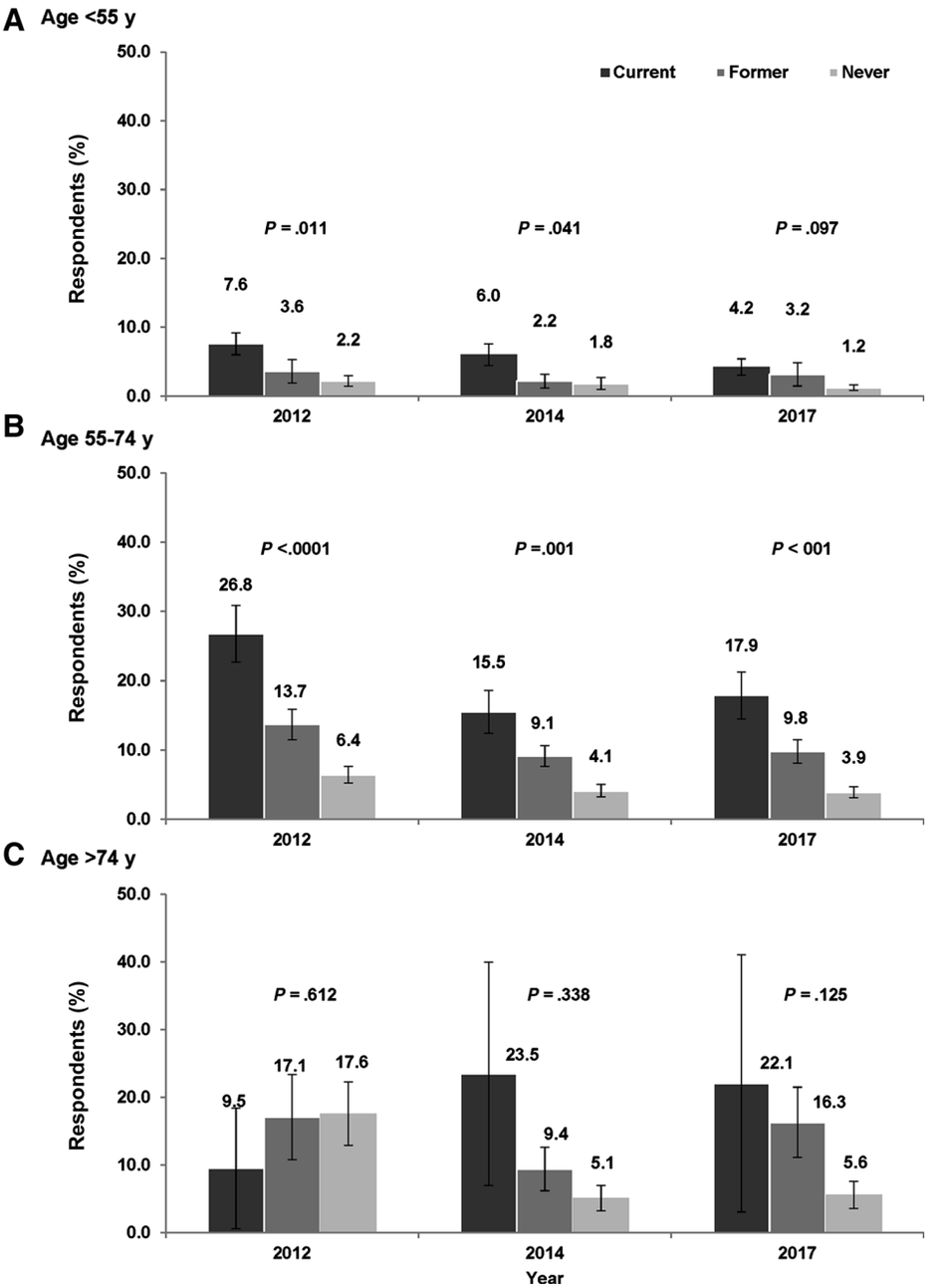

Figure 2.
The prevalence of physician–patient discussion about lung cancer screening by the age group. The prevalence of physician–patient discussion about lung cancer screening is relatively low in the study samples ages less than 55 years old (**A**). This rate is significantly higher in study samples ages 55 to 74 years old (**B**). The highest overall rates of physician–patient discussion about lung cancer screening are in the study sample ages >74 years old (**C**). (The unweighted sample size for the current smokers older than 74 years of age was low in all 3 years. The prevalence of current smokers older than 74 years of age had lower rate of discussion about lung cancer screening than that of the former smokers and never smokers in 2012 is mostly because of the sample size of this specific group.)

analysis. The estimated crude prevalence of physician–patient discussion among the survey sample was 11.3% among those considering quitting smoking in the next 6 months and 7.5% among those who are not considering quitting ($P < 0.0001$). In addition, for patients who have stopped and not stopped smoking for one day or longer in the previous year before the survey, the rates of physician–patient discussion about lung cancer screening were 11.5% versus 7.3% ($P < 0.0001$). As shown in Table 3, both intent to quit and attempt to quit were not significantly associated with physician–patient discussion about lung cancer screening among current smokers (intent to quit: OR, 1.22; 95% CI, 0.62–2.40; $P = 0.560$; attempt to quit: OR, 1.61; 95% CI, 0.75–3.46; $P = 0.219$) after adjusting for samples' demographic and clinical variables.

Discussion

Examination of 2012, 2014, and 2017 HINTS data suggested that the overall rates of physician–patient discussion about lung cancer screening in the adult U.S. non-institutionalized population had been very low, regardless of samples' age or smoking status. Over this 6-year period, there has no substantial variation in the prevalence of communication regarding lung cancer screening during patient–physician encounters from 2014 to 2017, but a

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Table 2. Multivariable model on predictors of screening consultation for lung cancer

	Full model		Reduced model	
Effect	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***
Year				
2012	1.00		1.00	
2014	1.79 (1.23–2.60)	0.002	1.70 (1.26–2.29)	0.001
2017	1.03 (0.66–1.59)	0.912	1.02 (0.70–1.48)	0.932
Age Group				
18–54	1.00		1.00	
55–77	3.18 (2.20–4.59)	0.027	3.25 (2.28–4.61)	0.013
78+	4.61 (2.36–9.02)	0.002	4.77 (2.76–8.27)	<0.0001
Sex				
Male	1.00			
Female	0.78 (0.55–1.11)	0.163		
Race/Ethnicity				
Non-Hispanic white	1.00		1.00	
Non-Hispanic black	2.19 (1.24–3.87)	0.007	2.18 (1.33–3.56)	0.002
Hispanics	2.09 (1.26–3.48)	0.005	1.89 (1.28–2.78)	0.001
Other	1.86 (0.92–3.76)	0.082	1.86 (0.96–3.58)	0.065
Education				
Less than high school	1.00			
High school graduate	0.78 (0.47–1.30)	0.364		
Some college	0.86 (0.50–1.49)	0.891		
College graduate or higher	0.88 (0.50–1.53)	0.984		
Marital status				
Single	1.00			
Divorced/widowed/separated	1.04 (0.61–1.78)	0.561		
Married	0.87 (0.45–1.65)	0.503		
Family Income				
Less than $20,000	1.00			
$20,000 to < $35,000	0.89 (0.52–1.52)	0.723		
$35,000 to < $50,000	0.62 (0.34–1.14)	0.144		
$50,000 to < $75,000	0.75 (0.49–1.16)	0.546		
$75,000 or more	0.96 (0.53–1.74)	0.476		
Employment				
Not employed	1.00			
Employed	1.06 (0.75–1.52)	0.733		
Census Region				
Northeast	1.00		1.00	
Midwest	0.47 (0.25–0.86)	0.015	0.47 (0.28–0.79)	0.005
South	0.56 (0.33–0.95)	0.032	0.55 (0.36–0.85)	0.007
West	0.54 (0.31–0.96)	0.036	0.58 (0.38–0.89)	0.013
Health Insurance				
No	1.00			
Yes	1.65 (0.67–4.09)	0.276		
General Health				
Poor	1.00			
Fair	0.95 (0.46–1.97)	0.274		
Good	1.12 (0.48–2.60)	0.953		
Very good	1.33 (0.60–2.94)	0.246		
Excellent	1.17 (0.40–3.42)	0.853		
Smoking Status				
Never	1.00		1.00	
Former	1.82 (1.22–2.73)	0.004	1.90 (1.33–2.73)	0.000
Current	4.22 (2.70–6.59)	<0.0001	3.93 (2.73–5.66)	<0.0001
Diagnosed with cancer other than lung cancer				
No	1.00		1.00	
Yes	1.79 (1.25–2.57)	0.002	1.93 (1.45–2.57)	<0.0001
Diagnosed with lung cancer				
No	1.00		1.00	
Yes	11.37 (1.93–67.04)	0.007	5.79 (1.68–19.95)	0.005
Family history of any cancer				
No	1.00			
Yes	1.19 (0.81–1.74)	0.424		
Not sure	0.97 (0.46–2.06)	0.752		
Diabetes				
No	1.00		1.00	
Yes	1.38 (0.97–1.95)	0.070	1.43 (1.05–1.96)	0.023

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Table 2. Multivariable model on predictors of screening consultation for lung cancer (Cont'd)

	Full model		Reduced model	
Effect	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***
High blood pressure				
No	1.00		1.00	
Yes	1.51 (1.06–2.17)	0.024	1.37 (1.01–1.86)	0.045
Heart disease				
No	1.00			
Yes	1.27 (0.85–1.90)	0.235		
Lung disease				
No	1.00		1.00	
Yes	2.77 (1.95–3.95)	<0.0001	2.68 (1.93–3.71)	<0.0001

significant decrease compared with the rate in 2012. Moreover, we found that physician–patient discussion about lung cancer screening was not associated with current smokers' intent to quit and attempt to quit smoking.

These results are consistent with an earlier study of the National Health Interview Survey (NHIS) population. That study, based on 2015 NHIS data, showed that the use of lung cancer screening was at a very low rate of 2.1% in the general population and 5.8% among high-risk smokers (17). Our study uses the 2017 HINTS data, demonstrated that the prevalence of patient–physician discussion about lung cancer screening is 4.3% only in the general population and 8.7% among current smokers. Such a low rate of discussion about lung cancer screening suggests that lung cancer screening was substantially underused and was not successfully penetrating the population of high-risk smokers who would most benefit from this screening technique.

Even though lung cancer screening can reduce cancer-related mortality by 20% for the high-risk smokers, it may bring no benefits to the individuals who are not eligible. The NHIS study also showed that the use of lung cancer screening significantly increased from 2010 to 2015 for individuals who were ineligible for lung cancer screening with LDCT (17). The present study brought up a similar issue of concern on the spillover effect of lung cancer screening that never smokers or smokers of ineligible age also expressed interest in lung cancer screening. Some of these patients who underwent lung cancer screening would receive invasive diagnostic procedures and would thus be exposed to the risks of post-procedural complications and related costs (18). Our finding highlights the importance of shared decision-making: Most of this discussion among the ineligible population, including ages less than 55, older than 77, or never smokers, should emphasize the harms of pursuing lung cancer screening and increased awareness of lung cancer screening among these individuals to prevent unwarranted use.

People who undergo a discussion about lung cancer screening are expected to have a stronger motivation to quit smoking, and the discussion process is a unique opportunity to engage current smokers in modifying their smoking behavior. However, many studies demonstrated the receipt of lung cancer screening is not strongly linked to smoking cessation (19). Our study showed the physician–patient discussion was not associated with any smoking behavior change, neither considering quitting smoking in the next 6 months nor stopping smoking for one day or longer in the past year. The question then is how to interpret these conflicting results from various studies. Effective smoking cessation counseling requires both patient and physician engagement, well-trained healthcare professionals, and sufficient length and number of sessions to discuss concerns and difficulties. However, a significant variation in the quality of smoking cessation counseling services exists among different facilities that offered lung cancer screening (20–22). The findings in this large national sample, together with those of other clinical studies with similar findings, suggest that a simple physician–patient discussion about lung cancer screening alone may not be sufficient to build lasting motivation for current smokers to modify their smoking behavior successfully.

The substantial low-penetration rate of physician–patient discussion reported by current smokers and former smokers examined in the national survey highlight the importance of community-based efforts to promote lung cancer screening using LDCT. Currently, many provider-side barriers have been observed in promoting lung cancer screening. The first barrier is primary care physicians' belief in lung cancer screening. In 2013, the American Academy of Family Physicians concluded that the evidence is insufficient to recommend lung cancer screening, and this sole recommendation against lung cancer screening underlined the significant concern from healthcare providers on the harms of lung cancer screening, such as long-term harms from radiation exposure and harms from follow-up interventions after positive tests (23, 24). Lack of awareness of lung cancer screening and related guidelines among primary care physicians is also a barrier. A study conducted in the Stanford Health Care (SHC) system showed that only 31% of healthcare providers answered the lung cancer eligibility criteria correctly (25). The study by Lewis and colleagues using a survey of healthcare providers at an academic medical center reported that 24.3% did not know any of the lung cancer screening guidelines, and about one third of providers did not know the effectiveness of LDCT in reducing lung cancer–related mortality.

This study was subject to several limitations. First, the type of lung cancer screening technique discussed between physicians and patients was not documented and may include a technique that is not effective, such as X-rays. Also, the content of physician–patient discussion on lung cancer screening was unknown, and in-depth discussion of the benefits and harms of lung cancer screening may link to a stronger motivation to quit smoking than a general discussion on lung cancer screening. Third, the survey lacks information on the pack-year history, so some of the current and former smokers ages 55 to 77 in our study cohort may be not eligible for lung cancer screening due to pack-year smoking history less than 30. Fourth, due to the cross-sectional study design, we were also not able to follow the samples as to whether they pursued lung cancer screening after a discussion with their physicians. Fifth, the question on the HINTS asking about "having

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Table 3. Multivariable model on predictors of screening consultation for lung cancer among current smokers

	Full model		Reduced model	
Effect	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***
Year				
2012–13	1.00		1.00	
2014	2.03 (0.99–4.14)	0.053	1.76 (1.00–3.22)	0.049
2017	1.22 (0.58–2.57)	0.606	1.14 (0.63–2.08)	0.665
Age Group				
18–54	1.00		1.00	
55–77	3.68 (1.68–8.10)	0.001	3.49 (2.07–5.90)	<0.0001
78+	2.33 (0.04–142.15)	0.687	2.04 (0.25–16.61)	0.505
Sex				
Male	1.00			
Female	1.47 (0.80–2.71)	0.216		
Race/Ethnicity				
Non-Hispanic white	1.00		1.00	
Non-Hispanic black	3.07 (1.39–6.79)	0.006	3.66 (2.05–6.54)	<0.0001
Hispanics	3.18 (1.23–8.25)	0.017	3.09 (1.58–6.05)	0.001
Other	3.87 (1.17–12.85)	0.027	4.46 (1.51–13.22)	0.007
Education				
Less than high school	1.00			
High school graduate	1.09 (0.43–2.79)	0.928		
Some college	0.90 (0.32–2.52)	0.582		
College graduate or higher	1.30 (0.50–3.37)	0.398		
Marital status				
Single	1.00			
Divorced/widowed/separated	0.89 (0.40–1.94)	0.906		
Married	0.72 (0.39–1.35)	0.353		
Family income				
Less than $20,000	1.00			
$20,000 to <$35,000	1.44 (0.46–4.48)	0.934		
$35,000 to <$50,000	1.00 (0.30–3.34)	0.353		
$50,000 to <$75,000	2.15 (0.84–5.53)	0.174		
$75,000 or More	2.38 (0.77–7.30)	0.144		
Employment				
Not employed	1.00			
Employed	0.68 (0.31–1.49)	0.339		
Census region				
Northeast	1.00			
Midwest	0.60 (0.24–1.53)	0.288		
South	0.97 (0.41–2.27)	0.941		
West	0.43 (0.11–1.69)	0.224		
Health insurance				
No	1.00		1.00	
Yes	2.71 (1.01–7.27)	0.048	3.16 (1.42–7.04)	0.005
General health				
Poor	1.00			
Fair	1.68 (0.40–7.01)	0.629		
Good	1.19 (0.30–4.71)	0.536		
Very good	2.58 (0.46–14.60)	0.107		
Excellent	1.04 (0.07–16.56)	0.728		
Considered quitting smoking				
No	1.00			
Yes	1.22 (0.62–2.40)	0.560		
Tried quitting smoking				
No	1.00			
Yes	1.61 (0.75–3.46)	0.219		
Diagnosed with cancer other than lung cancer				
No	1.00			
Yes	1.14 (0.56–2.33)	0.713		
Diagnosed with lung cancer				
No	1.00			
Yes	0.85 (0.09–7.88)	0.885		
Family history of any cancer				
No	1.00			
Yes	0.65 (0.32–1.33)	0.070		
Not sure	1.92 (0.38–9.65)	0.255		
Diabetes				
No	1.00			
Yes	1.65 (0.78–3.47)	0.187		

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Table 3. Multivariable model on predictors of screening consultation for lung cancer among current smokers (Cont'd)

	Full model		Reduced model	
Effect	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***
High blood pressure				
No	1.00			
Yes	1.30 (0.63–2.67)	0.478		
Heart disease				
No	1.00		1.00	
Yes	3.37 (1.20–9.45)	0.021	3.23 (1.30–8.04)	0.012
Lung disease				
No	1.00		1.00	
Yes	3.78 (1.80–7.95)	0.000	3.01 (1.75–5.18)	<0.0001

a test to check for lung cancer" is not limited to discussions specifically on lung cancer screening, and it is possible a discussion focused on invasive diagnostic procedures for lung abnormalities. Sixth, the impact of provider factors, such as availability of LCS program and physician attitude on discussion about lung cancer screening, was not captured in the HINTS data. Despite these limitations, the study also has many strengths, including the representativeness of the study sample from this national survey data, the timely reporting of the patterns in physician–patient discussion about lung cancer screening by combining three waves of surveys from 2012 to 2017, and quantifying the association between physician–patient discussion about lung cancer screening and smoking behavior modification in the context of promoting lung cancer screening on a national level.

In conclusion, our study provided nationally representative estimates of the prevalence of physician–patient discussion about lung cancer screening among different age groups stratified by smoking status. We found that the very low rate of communication on lung cancer screening was initiated in physician–patient encounters. The study sample was not precisely classified based on the lung cancer screening eligibility criteria; nevertheless, it will be important for physicians to counsel patients across a spectrum of lung cancer risk. Better recognition of the effectiveness of lung cancer screening among people who are current or former smokers at a high risk of lung cancer and harms of lung cancer screening among ineligible population is warranted. Improved communication regarding lung cancer screening by primary care providers will help to reduce the economic and social burdens of lung cancer and reduce lung cancer–related mortality, as well as the loss of quality of life among high-risk smokers.

Disclosure of Potential Conflicts of Interest

D.J. Wilkie is chairman and founder of eNursing LLC. No potential conflicts of interest were disclosed by the other authors.

Disclaimer

The content is solely the responsibility of the authors and does not necessarily represent the official views of the UF Health Cancer Center.

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Analysis and interpretation of data (e.g., statistical analysis, biostatistics, computational analysis): J. Huo, Y.-R. Hong, J. Bian, Y. Guo, A.G. Mainous III
Writing, review, and/or revision of the manuscript: J. Huo, Y.-R. Hong, J. Bian, Y. Guo, D.J. Wilkie, A.G. Mainous III
Administrative, technical, or material support (i.e., reporting or organizing data, constructing databases): J. Huo, Y.-R. Hong
Study supervision: J. Huo

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