Preventive Medicine 124 (2019) 84–90

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

Race and sex differences in patient provider communication and awareness of lung cancer screening in the health information National Trends Survey, 2013–2017

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ARTICLE INFO

Keywords:
Lung neoplasms
Mass screening
Sex
Awareness
Communication

ABSTRACT

Despite demonstrated reduction in lung cancer mortality, lung cancer screening uptake has been low. We investigated differences in discussions with physicians about lung cancer screening and awareness using repeated cross-sectional data from three cycles [4.2 (2013); 4.4(2014) and 5.1 (2017)] of the Health Information National Trends Survey. We included 4207 respondents age 55 to 80 who responded to this question: 'In the past year, have you talked with your doctor about having a test to check for lung cancer?'. We used logistic regression accounting for complex sample weighting to generate multivariable adjusted odds ratios (ORs) and 95% confidence intervals (CIs). The proportion of participants reporting lung cancer screening discussions was low and did not increase over time. In the most recent cycle, 15.7% of current smokers and 9.9% of former smokers said they had discussed screening. Compared to males, females were 32% less likely to report a lung cancer screening discussion (OR: 0.68, 95% CI: 0.50–0.93) and the association was strongest among non-Hispanic White females. Estimates were similar among never (OR: 0.72, 95% CI: 0.43–1.20), current (OR: 0.73, 95% CI: 0.39–1.36), and former (OR: 0.66, 95% CI: 0.40–1.10) smokers. Females were 32% less likely than males to be aware of a lung cancer screening test (OR: 0.68, 95% CI: 0.47–0.99) and this association was strongest for non-Hispanic Black females (OR: 0.38, 95% CI: 0.19–0.77). Too few providers have discussed lung cancer screening with potentially eligible patients, particularly female patients. Further research is needed to evaluate possible causes for this finding.

1. Introduction

Lung cancer is the leading cause of cancer death in US males and females with an estimated 154,050 deaths in 2018 (Siegel et al., 2018). On average, only 18% of lung cancer cases survive five years (Jemal et al., 2017). The high case-fatality rate of the disease is driven by the predominance of late stage diagnosis, with 57% of cases diagnosed at distant stage (Siegel et al., 2018). In an important step forward for lung cancer early detection, in 2011 the National Lung Screening Trial (NLST) demonstrated a 20% reduction in mortality associated with annual screening via low-dose computed tomography (LDCT) (Aberle et al., 2011). In 2013 the United States Preventive Services Task Force (USPSTF) recommended annual LDCT screening among current and former smokers (quit within last 15 years), age 55 to 80 with at least a 30 pack-year smoking history (Moyer, 2014). American Cancer Society recommendations are similar except they limit eligibility to individuals age 55–74 (Wender et al., 2013). In 2015 the Centers for Medicare and Medicaid Services (CMS) announced they would provide coverage for LDCT screening for asymptomatic current or former smokers (quit within last 15 years), aged 55–77, with a 30 pack-year tobacco smoking history (Centers for Medicare and Medicaid Services, 2015). Results of the NELSON trial, presented at the International Association for the Study of Lung Cancer's 19th World Conference on Lung Cancer, demonstrate even greater benefits of LDCT. This Netherlands-based RCT of 15,792 individuals at high risk of lung cancer, showed that with at least 10 years of follow-up, LDCT was associated with a 26% reduction in lung cancer mortality among asymptomatic men, with suggestions that the effect was even stronger among women (De Koning et al., 2018). If all eligible individuals received annual LDCT, estimates suggest that over 12,000 lung cancer deaths could be prevented each year

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https://doi.org/10.1016/j.ypmed.2019.05.001
Received 29 October 2018; Received in revised form 26 April 2019; Accepted 1 May 2019
Available online 02 May 2019

(Ma et al., 2013).

Yet, while screening rates are increasing, they remain quite low. Nationally representative survey data demonstrates that only 5.8% of high-risk current or former smokers received lung CT scans in 2015 compared to 2.9% in 2010 (Huo et al., 2017), and other studies estimate that the percent screened may be as low as 1.9% (Jemal and Fedewa, 2017; Pham et al., 2018). LDCT use among individuals that do not meet screening criteria, including never smokers, and continued use of non-guideline concordant chest x-ray remains common (Huo et al., 2017). While uptake has been universally low, there is some suggestion that it is even worse among black patients (Japuntich et al., 2018), at least partially because Blacks are less likely to meet screening eligibility criteria (Holford et al., 2016). Shared decision-making between patients and clinicians is recommended by USPSTF and required by Medicare prior to LDCT lung screening referral (Moyer, 2014; Centers for Medicare and Medicaid Services, 2015). Limited patient provider communication about lung cancer screening and awareness of screening could contribute to low screening uptake. Therefore, using data from the Health Information National Trends Survey (HINTS) a nationally representative cross-sectional survey conducted by the National Cancer Institute, we examined the extent to which participants reported discussions with health care providers about lung cancer screening, describe whether discussions have increased over time, and investigated whether there were race and/or gender differences in discussions and awareness of a test for lung cancer early detection.

2. Materials and methods

2.1. Study population

HINTS is a repeated cross-sectional survey of the U.S. adult, civilian, non-institutionalized population. Data for this study were collected by questionnaires mailed in three time periods: October 2012 through January 2013 (HINTS 4, Cycle 2; $n = 3630$); August through November 2014 (HINTS 4, Cycle 4; $n = 3677$); January through May 2017 (HINTS 5, Cycle 1). The sample design for each cycle was a two-stage, stratified sample. First, addresses were randomly selected from a U.S. Postal Service file of residential addresses, and then individual respondents were selected within each sampled household. Response rates in each cycle ranged from 40% (HINTS 4, Cycle 2) to 34.4% (HINTS 4, Cycle 4). HINTS design and methodology details have been published elsewhere (Nelson et al., 2004). We restricted the sample to adults age 55–80 years and excluded survey respondents with missing sex ($N = 48$), race/ethnicity ($N = 451$), smoking status ($n = 24$) and those who did not respond to the question on patient-provider communication regarding lung cancer screening ($N = 156$) leaving an analytical sample of 4207 men and women.

2.2. Exposure, outcome, and covariate assessment

Race/ethnicity and sex were self-reported. We characterized participant sex as male or female. Race/ethnicity was grouped into six categories: Hispanic, non-Hispanic (NH) White, NH-Black, NH-Asian, NH-Other or Unknown race. We present estimates for sex, race/ethnicity, and cross-classified race/ethnicity (Hispanic male, Hispanic female, NH-White male, NH-White female, NH-Black male, NH-Black female, NH-Asian or other male, NH-Asian or Other male). We used the following question to assess patient-provider communication regarding lung cancer screening: ‘At any time in the past year, have you talked with your doctor or other health professional about having a test to check for lung cancer?’. Using data from HINTS 4, Cycle 4 (2015) only, we used one question to assess participant awareness of lung cancer screening availability: ‘Have you heard of any tests to find lung cancer before the cancer creates noticeable problems?’. Participants were not asked whether, or when, they had been screened for lung cancer.

2.3. Statistical analysis

To provide representative estimates of the U.S. population and compute appropriate standard errors, we accounted for HINTS’ complex survey design using 150 replicate weights (50 for each cycle), calculated using the jackknife variance estimation method. This ensured valid inferences from the sample to the U.S. population, correcting for non-response and non-coverage bias. We used chi-square tests to compare differences in proportions within each cycle by sex or race/ethnicity age and Cochran–Armitage tests for trend were used to assess time trends across the cycles within each sex or racial/ethnic group. Multivariable logistic regression models were used to generate odds ratios (OR) and 95% confidence intervals (CI) overall and stratified by smoking status. Data on smoking duration and frequency, necessary to identify current or former smokers meeting USPSTF or Medicare screening eligibility criteria were not available from the survey.

We present models adjusted for sociodemographic and health related factors including: age (55–60, 60–65, 65–70, 70–75, 75–80); educational attainment (less than high school, 12 years of school or completed high school, some college, college graduate or greater); income ($<$ \$20,000, \$20,000 to \$34,999, \$35,000 to \$49,999, \$50,000 to \$74,999, $\geq$\$75,000); geographic region (Northeast, Midwest, South, West); urban/rural residence (metro area $\geq$1 M residents, Metro area 250 K to 1 M residents, Metro area $<$ 250 K residents, Non-Metro area 20 K residents, Non-Metro 2.5 K–19 K residents, Rural); time since last medical checkup (0–2 years, 3–5 years, $\geq$5 years or never); lung disease diagnosis (yes/no); family history of cancer (yes, no, not sure); marital status (Married or living as married, Divorced, widowed or separated, Single, never married); personal history of cancer (yes/no), health insurance status (yes/no); presence of regular health care provider (yes/no), self-rated health status (excellent or very good, good, fair or poor), and survey cycle (4.2, 4.4, or 5.1). Smoking status (never, former, current) was used as a covariate and as a stratification factor. Missing indicators were included for covariates to account for missing data. Tests for statistical significance use alpha of 0.05. Statistical analysis was conducted in 2018 using SAS version 9.4.

3. Results

Participant mean age was 64.5 years (Table 1). Females and males had similar mean age, however NH-White (64.7 years) and Hispanic (64.3 years) participants were somewhat older than NH-Black (63.2 years) or NH-Asian or other race (63.2 years). Most respondents were never smokers (52.8%, $N = 2249$). As compared to females (29.6%, $N = 678$), males (38.3%, $N = 712$) were more likely to be former smokers, but there was a similar sex distribution of current smokers (13.1% vs. 13.9%). NH-Whites were more likely to be former (36.5%, $N = 1053$) smokers, and NH-Blacks were more like to be current smokers (19.1%, $N = 117$), as compared to other racial/ethnic groups. There were also sex and racial/ethnic differences in education, household income, geographic region, marital status, health care quality, and rural/urban residence.

3.1. Trends in lung cancer screening discussion

In the most recent survey cycle, only 18.6% (95% CI:11.4%–25.9%) of current smokers and 11.4% (95% CI:5.7%–17.2%) of former smokers reported discussing lung cancer screening with a health care provider in the past year (Fig. 1A). Among ever smokers, the percentage was 12.8% (95% CI: 9.2, 16.4; data not shown). We found no evidence that patient provider communication about lung cancer screening has increased over time. In addition, females were less likely than males to have discussed lung cancer screening with a health care provider (Fig. 1B) in cycles 4.2 (2013) and 5.1 (2017), and this was true of never, former and current smokers (Fig. 1C and D). Similarly, we did not observe increases in lung cancer screening discussions over time among any racial/ethnic

Table 1
Characteristics of HINTS participants age 55–80, according to sex and race/ethnicity, cycles 4.2 (2013), 4.4 (2015), 5.1 (2017).

			Sex				Race/ethnicity							
	Total		Females		Males		Hispanic		NH-White		NH-Black		NH-Asian or other race	
	N = 4207		*N* = 2356		*N* = 1851		*N* = 467		*N* = 2887		*N* = 600		*N* = 253	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Age (years)	64.5	0.08	64.5	0.13	64.5	0.13	64.3	0.59	64.7	0.09	63.2	0.35	63.2	0.66
	N	**%**[a]	**N**	**%**[a]	**N**	**%**[a]	**N**	**%**[a]	**N**	**%**[a]	**N**	**%**[a]	**N**	**%**[a]
Smoking status														
Never	2249	52.8	1377	57.3	872	47.8	291	64.4	1480	50.3	316	54.3	162	67.0
Current	568	13.5	301	13.1	267	13.9	66	11.2	354	13.2	117	19.1	31	12.2
Former	1390	33.7	678	29.6	712	38.3	110	24.4	1053	36.5	167	26.5	60	20.9
Age group														
55–60	1057	30.0	603	29.8	454	30.1	123	35.1	677	28.3	174	33.9	83	39.0
60–65	1069	25.9	622	26.0	447	25.8	109	20.3	720	26.2	182	31.5	58	21.9
65–70	964	19.2	495	18.5	469	19.9	110	20.5	659	19.1	134	16.5	61	22.8
70–75	606	13.7	351	13.9	255	13.4	57	10.2	459	14.9	60	10.3	30	7.1
75–80	511	11.3	285	11.7	226	10.9	68	13.9	372	11.5	50	7.7	21	9.2
Sex														
Male	1851	47.7					204	49.1	1328	48.4	209	40.6	110	47.9
Female	2356	52.3					263	50.9	1559	51.6	391	59.4	143	52.1
Race														
Hispanic	467	9.2	263	9.0	204	9.5								
Non-Hispanic White	2887	76.9	1559	75.9	1328	77.9								
Non-Hispanic Black	600	9.0	391	10.2	209	7.7								
Non-Hispanic Asian or other race	253	4.9	143	4.8	110	4.9								
Education														
Less than high school	323	10.9	196	12.5	127	9.2	124	38.4	128	6.9	59	16.9	12	10.3
12 years or completed high school	919	23.3	574	25.0	345	21.4	108	20.1	613	23.3	159	29.2	39	19.1
Some college	1356	35.6	743	35.5	613	35.7	125	22.1	953	39.7	199	21.8	79	21.4
College graduate or higher	1593	30.2	835	27.0	758	33.7	104	19.4	1185	30.1	182	32.1	122	49.2
Household income[b]														
< $20,000	811	18.1	540	21.6	271	14.4	152	28.7	406	15.0	189	34.7	64	18.4
$20,000 to $34,999	588	14.4	353	15.3	235	13.5	81	21.7	381	13.6	96	16.5	30	10.8
$35,000 to $49,999	537	14.1	305	15.2	232	12.8	47	17.4	371	13.4	81	13.6	38	19.0
$50,000 to $74,999	661	19.6	345	19.1	316	20.1	50	15.4	498	20.4	83	16.8	30	20.2
≥ $75,000	1125	33.7	522	28.7	603	39.1	67	16.8	902	37.6	85	18.4	71	31.6
Region														
Northeast	700	19.0	400	18.9	300	19.1	76	17.4	517	20.1	75	14.8	32	12.9
Midwest	814	22.4	447	22.7	367	22.1	33	8.9	645	25.9	107	13.5	29	9.6
South	1730	37.0	988	37.4	742	36.5	201	36.9	1078	34.0	371	64.5	80	33.4
West	963	21.6	521	21.0	442	22.3	157	36.8	647	20.1	47	7.1	112	44.2
Married or living as married, %	2284	66.7	1087	61.7	1197	72.2	229	67.6	1702	68.6	217	48.2	136	68.9
Has personal history of cancer, %	864	16.8	496	17.5	368	16.0	70	12.0	667	18.0	88	14.1	39	11.6
Has family history of cancer, %	3006	70.7	1768	75.5	1238	65.5	288	60.6	2141	72.9	417	70.2	160	57.0
Excellent or very good health status, %	1505	36.5	850	35.6	655	37.4	162	36.2	1399	48.8	172	28.5	91	39.3
Has regular health care provider, %	1851	79.2	1842	79.1	1458	79.3	283	58.0	2388	82.3	446	76.9	183	73.9
Has health insurance, %	3880	93.4	2167	92.3	1713	94.6	405	88.0	2712	94.5	535	91.0	228	90.4
Medical checkup in past 2 years, %	3720	88.3	2104	89.5	1616	87.1	405	85.7	2552	88.2	538	91.7	225	89.3
Diagnosed with lung disease, %[c]	603	15.5	384	17.5	219	13.4	43	11.0	428	16.6	87	12.6	45	12.4
Excellent/very good quality health care, %	2949	81.5	1668	81.7	1281	81.2	282	73.4	2107	83.4	409	76.2	151	74.8
Urban metro area 1+ million people, %	2274	50.8	1271	50.4	1003	51.2	309	70.3	1407	46.0	390	63.1	168	67.0
Cycle														
4.2 (2013)	1272	31.3	711	31.7	561	30.8	137	28.8	885	31.7	185	31.7	65	29.1
4.4 (2015)	1486	32.0	822	31.9	664	32.0	177	34.3	997	31.8	228	33.7	84	27.7
5.1 (2017)	1449	36.7	823	36.3	626	37.2	153	36.9	1005	36.6	187	34.6	104	43.2

[a] Percentages presented are of non-missing data.
[b] Household income was not available for 485 respondents.
[c] Lung diseases include: Chronic lung disease, asthma, emphysema, or chronic bronchitis.

group. In the most recent survey cycle, among current smokers, 16.1 (95% CI:8.9%–23.4%) of NH-Whites reported discussion, compared to 27.1% (95% CI:0.0%–55.2%) of Hispanics, 24.3 (95% CI:0.17%–48.4%) of NH-Blacks and 21.6% (95% CI: 0.0%–53.2%) of NH-Asian or other race respondents (data not shown).

3.2. Gender disparities in lung cancer screening discussion

We observed declining lung cancer screening patient provider communication since the 2013 survey, and significant gender disparities in lung cancer screening patient provider communication which seemed to be driven by NH-White females (Table 2). Respondents in the 2017 survey cycle were 56% less likely to report a discussion about lung cancer screening with a healthcare provider compared to the 2013 survey cycle (OR: 0.64, 95% CI: 0.44–0.93). In age-adjusted models, females were 28% less likely (OR: 0.72, 95% CI: 0.53–0.99) to report patient provider communication about lung cancer screening compared to males. This association was strengthened after multivariable adjustment, demonstrating that females were 36% less likely to discuss lung cancer screening (OR: 0.64, 95% CI: 0.45–0.92). We observed no evidence that racial/ethnic minorities were less likely to discuss lung cancer screening with a health care providers. In

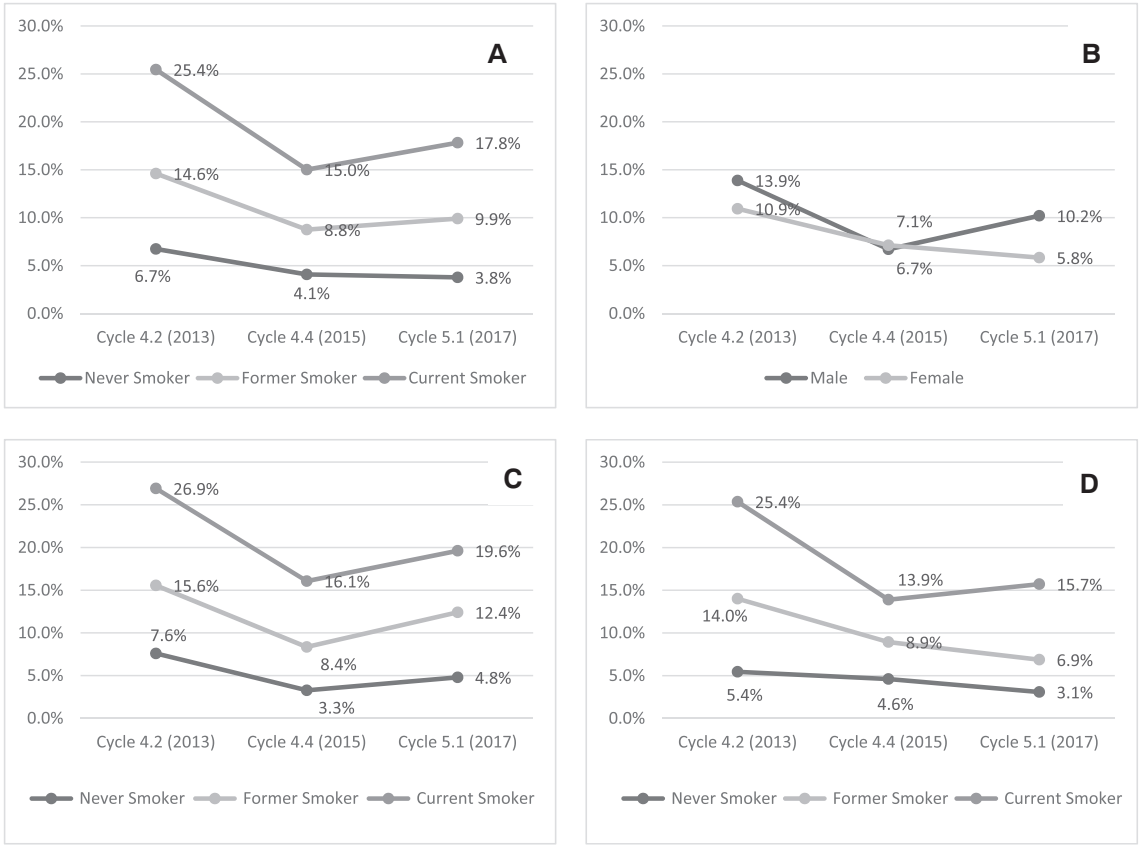

Fig. 1. Trends in lung cancer screening discussions over three HINTS survey cycles (2013–2017): A. By smoking status, B. By gender, C. By smoking status among male respondents, D. By smoking status among female respondents.

Table 2
Sex and race/ethnicity differences in discussions with health care providers about lung cancer screening, HINTS cycles 4.2 (2013), 4.4 (2015), 5.1 (2017).

	N	Events	Age-adjusted			Multivariable-adjusted[a]		
			OR	Upper CI	Lower CI	OR	Upper CI	Lower CI
Sex[b]								
Female	2356	176	0.72	0.53	0.99	0.64	0.45	0.92
Male	1851	199	1.00	Reference		1.00	Reference	
Race[c]								
Hispanic	467	53	1.32	0.88	1.98	1.81	1.09	3.01
Non-Hispanic White	2887	238	1.00	Reference		1.00	Reference	
Non-Hispanic Black	600	59	1.48	0.99	2.22	1.53	0.98	2.37
Non-Hispanic Asian or other race	253	25	1.37	0.78	2.41	2.16	1.12	4.17
Race/sex[d]								
Hispanic male	204	31	1.34	0.77	2.35	1.61	0.83	3.10
Hispanic female	263	22	0.85	0.45	1.63	1.13	0.55	2.34
NH-white male	1328	132	1.00	Reference		1.00	Reference	
NH-white female	1559	106	0.66	0.46	0.94	0.55	0.37	0.82
NH-black male	209	27	1.34	0.65	2.76	1.18	0.52	2.65
NH-black female	391	32	1.14	0.71	1.84	1.07	0.63	1.83
NH-Asian/other male	110	9	0.82	0.36	1.86	1.12	0.42	2.95
NH-Asian/other female	143	16	1.44	0.59	3.51	2.26	0.82	6.24
Survey cycle[e]								
4.2 (2013)	1272	153	1.00			1.00		
4.4 (2015)	1486	107	0.43	0.31	0.61	0.41	0.27	0.61
5.1 (2017)	1449	115	0.64	0.45	0.89	0.64	0.44	0.93

[a] All multivariable models adjusted for: smoking status, age group, lung disease diagnosis, time since last medical checkup, urban/rural residence, personal history of cancer, family history of cancer, self-rated health status, marital status, geographic region, educational attainment, and household income.
[b] Also adjusted for race and survey cycle.
[c] Also adjusted for sex and survey cycle.
[d] Also adjusted for survey cycle.
[e] Also adjusted for race and sex.

Table 3
Multivariable-adjusted sex and race/ethnicity differences in discussions with health care providers about lung cancer screening, stratified by smoking status, HINTS cycles 4.2 (2013), 4.4 (2015), 5.1 (2017).

	Never smokers					Current smokers					Former smokers				
	N	Number of events	OR	Upper CI	Lower CI	N	Number of events	OR	Upper CI	Lower CI	N	Number of events	OR	Upper CI	Lower CI
Sex															
Female	1377	60	0.67	0.39	1.17	301	58	0.70	0.35	1.40	678	58	0.64	0.37	1.13
Male	872	43	1.00	Reference		267	66	1.00	Reference		712	90	1.00	Reference	
Race															
Hispanic	291	24	3.17	1.61	6.23	66	17	1.83	0.78	4.29	110	12	1.06	0.40	2.82
Non-Hispanic White	1480	49	1.00	Reference		354	75	1.00	Reference		1053	114	1.00	Reference	
Non-Hispanic Black	316	17	3.02	1.25	7.31	117	25	1.61	0.68	3.84	167	17	1.20	0.58	2.48
Non-Hispanic Asian or other race	162	13	3.36	1.14	9.90	31	7	1.88	0.33	10.81	60	5	0.98	0.25	3.77
Survey cycle															
4.2 (2013)	671	43		Reference		179	56		Reference		422	54		Reference	
4.4 (2015)	783	35	0.56	0.30	1.06	196	26	0.26	0.10	0.69	507	46	0.45	0.25	0.80
5.1 (2017)	795	25	0.73	0.40	1.34	193	42	0.61	0.29	1.29	461	48	0.60	0.34	1.06

Note: model adjusted for: rage, lung disease, personal history of cancer, family history of cancer, with mutual adjustment for variables presented in table.

multivariable-adjusted models, compared to NH-Whites, NH-Blacks were 53% more likely (OR: 1.53, 95% CI: 0.98–2.37), Hispanics were 81% more likely (OR: 1.81, 95% CI: 1.09–3.01), and NH-Asian or other race participants were twice as likely (OR: 2.16, 95% CI: 1.12–4.17). Cross-classified race and gender revealed that NH-White women were 45% less likely to report discussing lung cancer screening with their health care providers (OR: 0.55, 95% CI: 0.37–0.82). There was little evidence of similar disparities for other groups.

Results were similar when stratified by smoking status (Table 3). In the two groups that may be eligible for lung cancer screening, current (OR: 0.70, 95% CI: 0.35–1.40) and former (OR: 0.64, 95% CI: 0.37–1.13) smokers and among never smokers (OR: 0.67, 95% CI: 0.39–1.17), females were less likely to discuss lung cancer screening, though these results did not reach statistical significance. Similarly, among current for former smokers, reports of lung cancer screening discussions were lower in the 2015 and 2017 survey cycles compared to 2013, though differences between 2013 and 2017 did not reach statistical significance. Racial differences in patient provider communication seemed to be driven by never smokers. For example, NH-Black never smokers were three times more likely to report discussing lung cancer screening with a health care provider than NH-Whites (OR: 3.02, 95% CI: 1.25–7.31). In exploratory analyses by race and gender, we again observed that NH-White females were less likely to discuss lung cancer screening, and the strongest association was among current smokers (OR: 0.49, 95% CI: 0.23–1.07). Results among current smokers were unchanged by further adjustment for smoking frequency (every day or some days).

3.3. Gender disparities in lung cancer screening awareness

Using data from cycle 4.4 only, we found significant gender and racial/ethnic differences in awareness of lung cancer screening (Table 4). In multivariable-adjusted models, compared to males, females were 32% less likely to have heard of a test for early detection of lung cancer (OR: 0.68, 95% CI: 0.47–0.99). NH-Blacks had a non-significant 29% lower likelihood of have lung cancer screening awareness (0.71, 95% CI: 0.43–1.14), while Hispanics were nearly twice as likely to have heard of a test for lung cancer (OR: 1.94, 95% CI: 1.11–3.39) compared to NH-Whites. Compared to NH-White males, NH-Black females were 62% less likely to know there was a test for lung cancer early detection (OR: 0.38, 0.19–0.77).

4. Discussion

Use of LDCT for lung cancer screening represents an opportunity for early detection and intervention in a disease that remains one of the most lethal cancers, yet screening uptake has been very low. Using data from three recent cycles of a nationally representative survey, we found that most current and former smokers have not discussed lung cancer screening with a healthcare provider and there have not been increases over time as would be expected with increasing receipt of lung cancer screening. These findings are potentially important contributors to the low uptake of screening observed in other studies. Provider recommendation is a very strong predictor of patient screening behavior (Peterson et al., 2016), and for lung cancer screening decision-making, patients prefer one-on-one discussions with their provider and decision-aids (Reuland et al., 2018; Kinsinger et al., 2017). Patients who are not aware that a test exists, and whose providers don't discuss screening are less likely to be screened. Importantly, we found that women, no matter their smoking status, were less likely to have discussed lung cancer screening with a provider, and it appeared that this association was driven by deficits among white women. Additionally, NH-Black women had less awareness of lung cancer screening than other groups. While educational and other interventions are needed for all patients, our study identifies specific groups that could benefit from focused attention and this is especially important given recent evidence that women may receive even greater mortality benefit from lung cancer screening than men (De Koning et al., 2018).

The overall proportion of current and former smokers that reported discussing lung cancer screening with a health provider was 17.8% in the 2017 survey cycle and had not increased since 2013. To put these numbers into context, according to estimates from the National Health Interview Survey, 24.6% of US ever-smokers aged 50 to 80 years met USPSTF lung cancer screening eligibility criteria in 2005, 22.8% in 2010, and 18.4% in 2015 (Cheung et al., 2018). Studies have demonstrated primary care providers (PCPs) have limited knowledge of lung cancer screening guideline criteria, uncertainty about LDCT effectiveness, and concerns about cost, false positives, and incidental findings (Lewis et al., 2015; Hoffman et al., 2015; Kanodra et al., 2016; Eberth et al., 2018). Specifically, an important barrier to PCP discussion and referral for lung cancer screening is the availability of quality and updated data on smoking status. LDCT eligibility is based on age, smoking status (current or former) and pack-year smoking history. Smoking status is routinely assessed and documented in medical records, but duration and frequency/intensity, are not, posing challenges for PCPs attempting to identify eligible patients (Cole et al., 2018). Expanded electronic medical record tools that allow PCPs to easily identify high-risk current and former smokers are needed. In the meantime, while PCPs may not be able to calculate pack-years using information in medical records, they can use it to identify patients that need additional

Table 4
Sex and Race/Ethnicity Differences in Awareness of Lung Cancer Screening Tests, HINTS Cycle 4.4 (2015).

	N	Number of events	Age-adjusted			Multivariable-adjusted		
			OR	Upper CI	Lower CI	OR	Upper CI	Lower CI
Sex								
Female	812	176	0.67	0.47	0.95	0.68	0.47	0.99
Male	657	193	1.00	Reference		1.00	Reference	
Race								
Hispanic	174	54	1.65	0.95	2.87	1.94	1.11	3.39
Non-Hispanic White	984	246	1.00	Reference		1.00	Reference	
Non-Hispanic Black	227	47	0.65	0.40	1.05	0.71	0.43	1.14
Non-Hispanic Asian or other race	84	22	0.80	0.40	1.62	0.91	0.43	1.96
Race/sex								
Hispanic male	68	25	1.95	0.90	4.22	2.30	0.97	5.50
Hispanic female	106	29	1.03	0.51	2.08	1.21	0.59	2.47
NH-white male	471	136	1.00	Reference		1.00	Reference	
NH-white female	513	110	0.70	0.46	1.05	0.73	0.47	1.14
NH-black male	84	22	0.80	0.39	1.62	0.88	0.40	1.94
NH-black female	143	25	0.39	0.19	0.78	0.38	0.19	0.77
NH-Asian/other male	34	10	0.70	0.27	1.83	0.84	0.30	2.35
NH-Asian/other female	50	12	0.64	0.22	1.90	0.77	0.22	2.72

Note: Adjusted for: smoking status, race, age group, time since last checkup, personal history of cancer, self-rated health status, perceived healthcare quality, household income.

assessment and discussion.

While there are multiple reasons why PCPs may not discuss lung cancer screening with patients, why they would be less likely to discuss it with women, and white women specifically, is less clear. Women are more likely to be never smokers than men (Jamal et al., 2018). This could lead providers to perceive women to be at lower lung cancer risk. There may be differences in smoking intensity and duration between male and female current and former smokers that make women less likely to meet eligibility criteria. Yet, among smokers, women are also less likely to successfully quit smoking and maintain long-term abstinence (Smith et al., 2016). Also, given that data on smoking intensity and duration is rarely available in medical records (Cole et al., 2018), this would likely require a discussion to determine a woman's screening eligibility. There is no evidence that women are less likely than men to disclose their smoking status to a health care provider (Stuber and Galea, 2009). There is conflicting evidence regarding the relationship between sex and lung cancer risk. Older studies tended to observe excess risk among female smokers (Papadopoulos et al., 2014; Zang and Wynder, 1996). However, those differences may have been because in older birth cohorts women had later age at smoking initiation among women and lower smoking frequency than men, while in more recent birth cohorts male and female smoking patterns have converged (Freedman et al., 2016).

While provider recommendation is important, patients can also initiate conversations about screening. Lack of discussion could result from several factors including, inadequate awareness of screening, limited lung cancer knowledge, stigma, and low perceived risk. Consistent with our findings, a previous study of high-risk smokers found that most had never heard of LDCT lung screening and had never received a recommendation for screening from a healthcare provider, and were not aware there was a screening test for lung cancer (Simmons et al., 2017). To some extent, lack of awareness may be because the recommendations for LDCT lung cancer screening are relatively new. In our study, the question on awareness was only asked in 2015, four years after NLST results were released, two years after USPSTF guidelines, and concurrent with Medicare screening coverage. It will be important to see how knowledge and awareness changes in the future. Timing likely contributes to low level of awareness overall, but does not explain why women, would be less likely to discuss lung cancer screening with a healthcare provider and be less aware. An analysis of 2005 HINTS data found that Blacks were more likely than Whites to express confusion over strategies to prevent lung cancer, fear, and belief that lung cancer is symptomatic (Lathan et al., 2010). However, they did not examine sex differences due to limited numbers of males in their sample. Less knowledge about lung cancer's consequences, fatalistic beliefs, and lack of self-efficacy to discuss LDCT with a healthcare provider are associated with lower intentions to screen among smokers (Jonnalagadda et al., 2012). While multiple studies have demonstrated racial and ethnic differences in these factors (Carter-Harris et al., 2018), less evidence is available to suggest differences by sex. Similarly, while lung cancer is more stigmatized than other cancers, and perceived blame and stigma are important screening deterrents (Quaife et al., 2017; Carter-Harris et al., 2017), evidence suggests that if there are sex differences in stigma, there are higher levels among males (Lebel et al., 2013). Perceived risk of lung cancer, which may influence screening awareness and behavior, differs by race with higher risk perception among Whites (Park et al., 2009). A 2016 survey of 1000 women by the American Lung Association found that they were unlikely to perceive lung cancer to be a cancer that impacts women and only 3% felt lung cancer was a leading health concern (American Lung Association, n.d.). More effort is needed to confirm and explain the sex disparities we observed in this study.

4.1. Study strengths and limitations

Our study has several important limitations. Most importantly, we could not restrict our analysis to high-risk current and former smokers that meet USPSTF or Medicare screening eligibility criteria because information on smoking frequency and duration necessary to calculate pack-years was not available from the HINTS survey. Additionally, as lung cancer screening behavior was not assessed in the HINTS survey, therefore we are unable to directly test whether patient-provider discussion or awareness of the screening test was associated with receipt of screening in this population. Studies using a longitudinal design or that test interventions patient-provider communication or screening awareness are needed. The HINTS survey, while designed to be nationally representative, does suffer from low response rates, and this sample was of relatively high socioeconomic status (> 30% had a college degree or greater or ≥$75,000 annual household income). No data on discussions about lung cancer screening or awareness of lung cancer screening are available from before the release of NLST results or USPSTF guidelines and we could not examine trends in awareness of lung cancer screening as that question was asked only once.

5. Conclusions

We must approach the process of large-scale implementation of LDCT lung cancer screening with equity in mind. This will require patient and provider education as well as IT infrastructure improvements to systematically identify patients eligible for LDCT lung cancer screening and prompt patient-provider shared decision-making, thereby reducing opportunities for bias.

Acknowledgments

There was no specific funding for this project. As such, the funder had no role in the study design or preparation of this manuscript.

Conflict of interest

The authors declare there is no conflict of interest.

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