Letters

RESEARCH LETTER

Lung Cancer Screening With Low-Dose Computed Tomography in the United States—2010 to 2015

Lung cancer is the most preventable and leading cause of cancer deaths in the United States, with about 155 870 deaths each year.[1] In December 2013, the United States Preventive Services Task Force (USPSTF) recommended annual screening for lung cancer with low-dose computed tomography (LDCT) for asymptomatic persons aged 55 to 80 years who have a 30 pack or more per year smoking history and currently smoke or have quit within the past 15 years.[2] According to the 2010 National Health Interview Survey (NHIS), only 2% to 4% of high-risk smokers received LDCT for lung cancer screening in the previous year.[3] In this study, we examined whether LDCT screening has increased following the USPSTF recommendation.

Methods | We used the 2010 and 2015 NHIS, which included 2347 respondents who met the USPSTF criteria for LDCT.[2] Self-

Table 1. Prevalence of LDCT Testing for Lung Cancer in the Past Year Among Screening-Eligible and Noneligible Smokers, National Health Interview Surveys 2010 and 2015[a,b]

	Total		2010		2015		
Characteristic	No. (%)	(95% CI)	No. (%)	(95% CI)	No. (%)	(95% CI)	*P* Value[c]
Screening-eligible smokers (n = 2167)							
Weighted No. receiving LDCT[d]			276 700		262 700		
Weighted No. eligible for LDCT			8 456 800		6 819 500		
Total	2167 (3.5)	(2.6-4.8)	1036 (3.3)	(2.3-4.7)	1131 (3.9)	(2.4-6.2)	.60
Smoking history							
Former, ≥30 PY, quit ≤15 years ago	1020 (4.2)	(2.7-6.5)	491 (4.0)	(2.6-6.1)	529 (4.6)[e]	(2.1-9.4)[e]	.76
Current, ≥30 PY	1147 (2.9)	(1.8-4.5)	545 (2.6)[e]	(1.4-4.9)[e]	602 (3.2)	(1.8-5.6)	.64
Age, y							
55-64	1119 (2.3)	(1.5-3.6)	554 (2.8)[e]	(1.6-5.1)[e]	565 (1.7)	(1.0-3.1)	.29
65-80	1048 (5.0)	(3.3-7.6)	482 (3.8)	(2.4-6.0)	566 (6.6)[e]	(3.6-11.9)[e]	.19
Sex							
Male	1245 (3.8)	(2.6-5.4)	597 (3.8)	(2.5-5.9)	648 (3.8)	(2.2-6.3)	.96
Female	922 (3.2)[e]	(1.7-5.7)[e]	439 (2.5)[e]	(1.2-5.0)[e]	483 (4.0)[e]	(1.6-9.5)[e]	.46
BMI							
<25	688 (5.6)	(3.4-9.3)	320 (4.4)[e]	(2.4-8.0)[e]	368 (7.2)[e]	(3.3-14.7)[e]	.36
≥25	1400 (2.6)	(1.8-3.7)	673 (2.7)	(1.7-4.3)	727 (2.5)	(1.5-4.2)	.84
Usual place for medical care							
Yes	1965 (3.9)	(2.9-5.3)	934 (3.6)	(2.5-5.2)	1031 (4.3)	(2.6-6.9)	.60
No	202 (0.2)[e]	(0.0-1.2)[e]	102[e,f]		100 (0.4)[e]	(0.1-2.6)[e]	[f]
Visited PCP in past year							
Yes	1726 (4.3)	(3.1-5.9)	813 (4.1)	(2.9-5.9)	913 (4.5)	(2.7-7.4)	.78
No	440 (0.6)	(0.2-1.8)	223[f]		217 (1.4)	(0.5-4.1)	[f]
Insurance type							
Uninsured or Medicaid	1230 (4.2)	(2.8-6.3)	586 (3.2)	(2.0-5.1)	644 (5.5)[e]	(3.0-9.9)[e]	.20
Medicare, private, or other	937 (2.8)	(1.7-4.4)	450 (3.4)	(1.9-6.1)	487 (2.0)[e]	(1.1-3.6)[e]	.20
Race[g]							
White	1787 (3.5)	(2.5-5.0)	833 (3.1)	(2.0-4.6)	954 (4.1)	(2.4-6.9)	.39
Nonwhite	380 (3.5)	(2.0-6.2)	203 (4.7)[e]	(2.3-9.5)[e]	177 (2.1)[e]	(1.0-4.6)[e]	.18
Education level							
<High school or high school graduate	1216 (3.4)	(2.4-4.9)	613 (2.6)	(1.6-4.1)	603 (4.6)	(2.9-7.3)	.08
Some college or college graduate	946 (3.7)	(2.2-6.2)	420 (4.3)	(2.5-7.3)	526 (3.0)[e]	(1.1-8.3)[e]	.51

(continued)

reported LDCT in the past year for lung cancer screening was the primary outcome of the study. Analyses excluded respondents with unknown (n = 6) or self-reported history of lung cancer (n = 41) or were missing LDCT testing information (n = 133), leaving 2167 adults available for analyses. Weighted prevalence of LDCT for lung cancer screening in the past year was calculated by factors of interest. Multivariable prevalence ratios of LDCT in the past year were estimated using predicted margins. All statistical analyses accounted for complex sampling design and were conducted with SAS callable SUDAAN statistical software (version 9.0.3, SAS Institute). The study was based on deidentified publicly available database and exempt from institutional review board and informed consent.

Results | From 2010 to 2015, the percentage of eligible smokers who reported LCDT screening in the past 12 months remained low and constant, from 3.3% in 2010 to 3.9% in 2015 (P = .60); an even lower proportion of noneligible smokers received LDCT (**Table 1**). Of the 6.8 million smokers eligible for LDCT screening in 2015, only 262 700 received it. Furthermore, there was no significant increase in screening from 2010 to 2015 for any of the sociodemographic groups, nor were there significant subgroup differences in screening, except between participants with or without a history of bronchitis (**Table 2**). Of note, over 50% (1230/2167) of smokers meeting USPSTF recommendations for LDCT screening were uninsured or Medicaid insured (Table 1).

Discussion | Screening for lung cancer using LDCT among eligible current and former smokers remained low and unchanged in 2015 following the 2013 USPSTF recommendation for annual screening. Reasons for exceptionally low uptake

Table 1. Prevalence of LDCT Testing for Lung Cancer in the Past Year Among Screening-Eligible and Noneligible Smokers, National Health Interview Surveys 2010 and 2015[a,b] (continued)

	Total		2010		2015		
Characteristic	No. (%)	(95% CI)	No. (%)	(95% CI)	No. (%)	(95% CI)	*P* Value[c]
Income, $							
<35 000	1130 (3.9)	(2.8-5.3)	543 (3.9)	(2.5-6.1)	587 (3.8)	(2.3-6.2)	.97
≥35 000	926 (3.3)	(2.0-5.4)	446 (2.8)	(1.5-5.0)	480 (3.9)[e]	(1.8-8.1)[e]	.51
Family history of lung cancer							
Yes	362 (4.5)[e]	(2.4-8.2)[e]	161 (4.8)[e]	(2.0-10.8)[e]	201 (4.1)[e]	(2.1-8.0)[e]	.76
No	1709 (3.3)	(2.3-4.8)	812 (2.8)	(1.9-4.4)	897 (3.9)	(2.1-6.9)	.42
Attempted to quit smoking in the past 12 months[h]							
Yes	363 (4.1)[e]	(2.1-8.0)[e]	164 (3.3)[e]	(1.2-8.8)[e]	199 (5.1)[e]	(2.1-12.3)[e]	.52
No	784 (2.3)	(1.3-3.9)	381 (2.3)[e]	(1.0-5.2)[e]	403 (2.2)[e]	(1.1-4.3)[e]	.93
Ever diagnosed with emphysema							
Yes	321 (8.9)	(5.8-13.4)	169 (9.6)	(5.8-15.5)	152 (7.9)[e]	(3.8-15.8)[e]	.64
No	1844 (2.6)	(1.7-3.9)	866 (2.0)	(1.2-3.4)	978 (3.2)[e]	(1.7-5.9)[e]	.30
Ever diagnosed with bronchitis							
Yes	272 (11.2)	(6.4-18.8)	135 (11.5)	(6.5-19.7)	137 (10.7)[e]	(3.6-27.7)[e]	.90
No	1895 (2.4)	(1.7-3.5)	901 (2.1)	(1.3-3.3)	994 (2.9)	(1.8-4.6)	.30
Ever diagnosed with asthma							
Yes	327 (6.2)	(3.7-10.1)	184 (8.0)	(4.4-14.0)	143 (3.2)[e]	(1.3-7.3)[e]	.08
No	1838 (3.1)	(2.1-4.5)	851 (2.3)	(1.5-3.7)	987 (4.0)	(2.3-6.7)	.16
Noneligible smokers (n = 6632)[i]							
Total	6632 (2.4)	(1.9-2.9)	2632 (2.0)	(1.5-2.9)	3989 (2.7)	(2.1-3.6)	.12
Former, <30 PY, quit ≤15 years ago	932 (2.3)	(1.3-4.1)	378 (3.1)	(1.5-6.3)	554 (1.7)	(0.7-4.4)	.36
Former, ≥30 PY, quit >15 years ago	740 (4.0)	(2.5-6.2)	339 (2.5)	(1.1-5.4)	401 (5.8)	(2.9-11.3)	.17
Former, <30 PY, quit ≥15 years ago	3334 (1.6)	(1.2-2.3)	1255 (1.5)	(0.9-2.5)	2079 (1.7)	(1.2-2.6)	.68
Current, <30 PY	1626 (3.3)	(2.3-4.6)	671 (2.0)	(1.2-3.5)	955 (4.4)	(2.8-6.6)	.04

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); LDCT, low-dose computerized tomography; PCP, primary care physician; PY, pack-years.

[a] The following number of respondents were missing data for these items and are shown in parentheses: income (111), BMI (79), PCP visits (1), education (5), immigration status (1), family history of lung cancer (96), emphysema (2), asthma (2). Respondents with missing information were included in the model, but data are not shown.

[b] Percentages are weighted.

[c] *P* value compares 2010 vs 2015.

[d] Weighted numbers take into account the assigned sampling weights of respondents.

[e] Unreliable estimates as a result of relative standard errors exceeding 30%.

[f] Unable to generate estimate owing to small denominator.

[g] White includes non-Hispanic whites, nonwhite includes: Hispanic, Asian, Black, Native American/Alaskan Native and other race and/or ethnicities.

[h] Among current smokers only.

[i] Includes former and current smokers who do not meet the US Preventive Services Task Force Recommendations.

Table 2. Adjusted Prevalence Ratios and 95% CIs of LDCT Testing for Lung Cancer in the Past Year Among Screening-Eligible Respondents, National Health Interview Survey 2010 and 2015 (n = 2167)[a,b]

Characteristic	PR (95% CI)
Year	
2010	1 [Reference]
2015	1.28 (0.66-2.47)
Age, y	
55-64	1 [Reference]
65-80	1.34 (0.62-2.88)
Sex	
Male	1 [Reference]
Female	0.61 (0.26-1.4)
BMI	
<25	1 [Reference]
≥25	0.36 (0.16-0.8)
Usual place for medical care	
Yes	1 [Reference]
No	0.12 (0.01-1.78)
Insurance type	
Uninsured or medicaid	1 [Reference]
Medicare, private, or other	0.94 (0.43-2.06)
Race[c]	
White	1 [Reference]
Nonwhite	1.31 (0.51-3.33)
Education level	
<High school or high school graduate	1 [Reference]
Some college or college graduate	1.13 (0.49-2.62)
Family history of lung cancer	
Yes	1 [Reference]
No	0.84 (0.32-2.21)
Smoking history	
Former, ≥30 PY, quit ≤15 years ago	1.27 (0.53-3.05)
Current, ≥30 PY	1 [Reference]
Attempted to quit smoking in the past 12 months[d]	
Yes	1 [Reference]
No	0.55 (0.17-1.71)
Ever diagnosed with emphysema	
Yes	1 [Reference]
No	0.60 (0.19-1.90)
Ever diagnosed with bronchitis	
Yes	1 [Reference]
No	0.27 (0.09-0.83)
Ever diagnosed with asthma	
Yes	1 [Reference]
No	0.91 (0.35-2.35)

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); LDCT, low-dose computerized tomography; PR, prevalence ratio; PY, pack-years.

[a] 192 participants were not included in the model owing to missing data. Visiting a physician in the past year and income level were not included in the model owing to instability of estimates.

[b] Prevalence Ratios are adjusted for: age, sex, race, smoking history, family of lung cancer, chronic respiratory conditions, and BMI.

[c] White includes non-Hispanic whites, nonwhite includes Hispanic, Asian, Black, Native American/Alaskan Native and other race/Ethnicities.

[d] Among current smokers only.

of screening may include gaps in smokers' knowledge regarding LDCT, lack of access to care as well as physicians' knowledge about screening recommendations[4] and reimbursement. For example, according to a 2015 survey of physicians in South Carolina, 36% of physicians correctly stated that LDCT screening should be conducted annually in high-risk individuals, and 63% of physicians did not know that Medicare covers LDCT for lung cancer screening.[4] It is also possible that physicians may be aware of LDCT screening, but have limited access to the high-volume, and high-quality radiology centers, a recommendation set forth by public health organizations[5] and a stipulation on Medicare reimbursement.[6] The decrease in the number of screening-eligible smokers from 8.4 million in 2010 to 6.8 million in 2015 reflects progress in tobacco control, and this has implications for the future provision of LDCT screening. Receipt of LDCT and smoking history were self-reported and subject to recall bias and the limited time following the USPSTF recommendation and Medicare-reimbursement are limitations of our study. Despite this, our study provides the first national estimate of LDCT following the USPSTF recommendation.

In conclusion, annual LCDT screening among heavy current and former smokers remains low and unchanged following the USPSTF recommendation despite the potential to avert thousands of lung cancer deaths each year. This underscores the need to educate clinicians and smokers about the benefit and risks of lung cancer screening for informed decision making.

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Association of Interactive Reminders and Automated Messages With Persistent Adherence to Colorectal Cancer Screening: A Randomized Clinical Trial

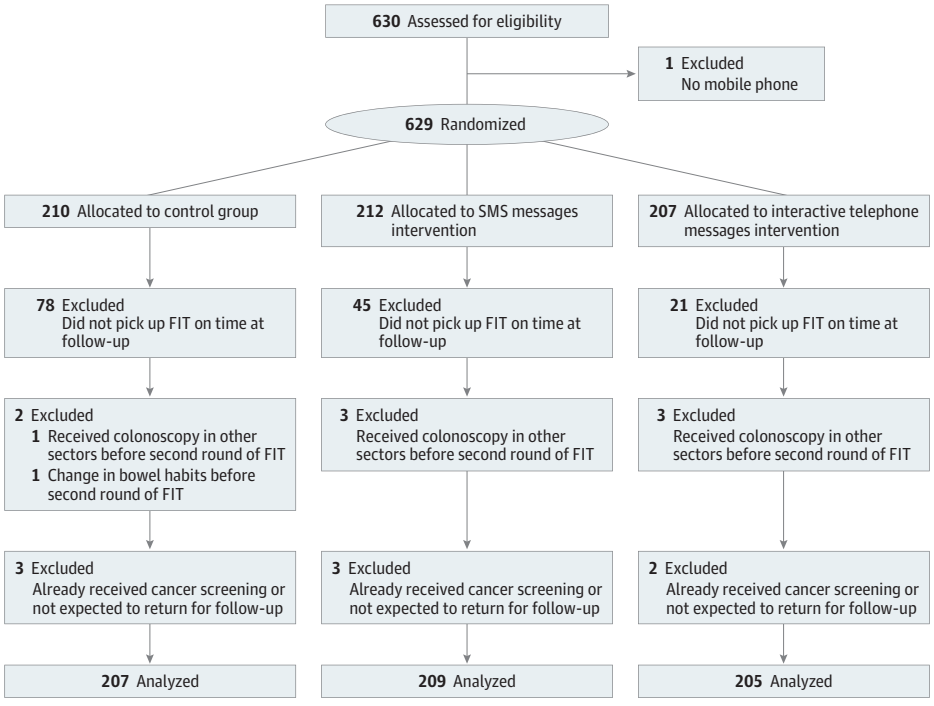
The US Preventive Services Task Force recommends annual fecal immunochemical test (FIT) as one of the colorectal cancer (CRC) screening tests.[1] Adherence to yearly FIT is crucial to programmatic success.[2] However, longitudinal adherence is low and strategies to improve persistent adherence are needed.[3] We evaluated the effectiveness of interactive telephone calls vs automated short message service (SMS) on improving adherence to FIT screening compared with usual care.

Supplemental content

Methods | We conducted a prospective randomized parallel group study, with the setting previously described.[4] The trial was registered on Clinicaltrials.gov (NCT02815436). Asymptomatic patients with negative FIT results in their first screening round from April to September 2015 due for annual screening in 2016 were eligible. Patients who could not understand telephone or SMS, or did not have mobile phones were excluded. Participants were randomized by a computer-generated sequence with an allocation ratio of 1:1:1. In the control group, participants were told in 2015 that they should visit the screening center for annual FIT pickup at the same calendar month of 2016. In the SMS group, subjects received a 1-way SMS, highlighting importance of CRC screening, and notifying date and location of FIT pickup on their mobile. In the telephone group, participants received a call from a trained health care physician with the same message as the SMS, but an interactive conversation was permitted. The interventions were delivered 1 month before the expected date of participant return for second round of screening. The Joint Chinese University of Hong Kong-New Territories East Cluster Clinical Research Ethics Committee approved the study and participant consent was waived because the interventions were an extension of the screening services. The trial protocol is provided in the Supplement.

Outcomes were rate of FIT pickup within 1 month of a patient's anticipated return, and rate of FIT return within 2 months of anticipated return. Six hundred patients provide 80% power (at 5% α level) for detecting an 11% increase in FIT return rate in the intervention groups compared with control, which was assumed to have a FIT return rate of 70%.[5] Associations between study groups and outcomes were examined by backward stepwise, binary logistic regression. Subgroup analysis for sex, marital status, household income, and educational level were performed, because these factors were previously found to be associated with screening adherence.[6]

Figure. Consort Flow Diagram



FIT indicates fecal immunochemical test.