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Factors Associated With Obtaining Lung Cancer Screening Among Persons Who Smoke

Kristin G. Maki, Kaiping Liao, Lisa M. Lowenstein, M. Angeles Lopez-Olivo, and Robert J. Volk

Abstract

Background. Screening with low-dose computed tomography scans can reduce lung cancer deaths but uptake remains low. This study examines psychosocial factors associated with obtaining lung cancer screening (LCS) among individuals. **Methods.** This is a secondary analysis of a randomized clinical trial conducted with 13 state quitlines' clients. Participants who met age and smoking history criteria were enrolled and followed-up for 6 months. Only participants randomized to the intervention group (a patient decision aid) were included in this analysis. A logistic regression was performed to identify determinants of obtaining LCS 6 months after the intervention. **Results.** There were 204 participants included in this study. Regarding individual attitudes, high and moderate levels of concern about overdiagnosis were associated with a decreased likelihood of obtaining LCS compared with lower levels of concern (high levels of concern, odds ratio [OR] 0.17, 95% confidence interval [CI] 0.04–0.65; moderate levels of concern, OR 0.15, 95% CI 0.05–0.53). In contrast, higher levels of anticipated regret about not obtaining LCS and later being diagnosed with lung cancer were associated with an increased likelihood of being screened compared with lower levels of anticipated regret (OR 5.59, 95% CI 1.72–18.10). Other potential harms related to LCS were not significant. **Limitations.** Follow-up may not have been long enough for all individuals who wished to be screened to complete the scan. Additionally, participants may have been more health motivated due to recruitment via tobacco quitlines. **Conclusions.** Anticipated regret about not obtaining screening is associated with screening behavior, whereas concern about overdiagnosis is associated with decreased likelihood of LCS. **Implications.** Decision support research may benefit from further examining anticipated regret in screening decisions. Additional training and information may be helpful to address concerns regarding overdiagnosis.

Keywords

anticipated regret, decision-making, low-dose CT scan, lung cancer screening, overdiagnosis

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Introduction

Lung cancer is a leading cause of cancer-related death in the United States. Specifically, less than one in five (18.6%) individuals diagnosed with lung cancer will survive 5 years after diagnosis; this is partly due to the late stage of diagnosis for most lung cancer patients.[1] The National Lung Screening Trial examined the efficacy of annual low-dose computed tomography (LDCT) scans with results showing a reduction of lung cancer deaths by 16% to 20% with LDCT screening for 3 consecutive years.[2] In 2013, the US Preventive Services Task Force

Corresponding Author

Robert J. Volk, Department of Health Services Research, The University of Texas MD Anderson Cancer Center, 1515 Holcombe Blvd, Unit 1444, Houston, TX 77030, USA; Telephone: (713) 745-4516 (bvolk@mdanderson.org).

(USPSTF) recommendation updated lung cancer screening (LCS) to a grade B,[3] and the most recent recommendation remains at that level.[4] The Centers for Medicare and Medicaid Services (CMS) will reimburse LCS for eligible individuals if their health care provider engages in a shared decision-making (SDM) consultation prior to screening.[5] However, uptake and adherence rates have remained low.[6,7]

Prior work has examined factors related to LCS uptake, focusing on demographic and behavioral factors. Specifically, research has shown that persons who currently smoke are more concerned about lung cancer and more interested in LCS than those who previously smoked.[8] Studies have also shown gender and racial differences in intentions and behavior regarding LCS.[9,10] For example, non-Hispanic White individuals may be more likely to undergo screening than other individuals.[10] Less is known about psychosocial factors relating to LCS uptake. One cross-sectional study's results showed positive associations between four factors and LDCT intentions: perceived accuracy of the LDCT for lung cancer detection, believing that early detection is associated with a better prognosis, perceived high individual risk of lung cancer, and not being afraid of CT scans.[11]

The present study is guided by the Ottawa Decision Support Framework,[12] which addresses the decisional needs, outcomes, and support of people who are making health-related choices. In this study, we aimed to examine the association between LCS behavior (completing LCS by the 6-month follow-up) and beliefs about LCS that aligned with information presented in the intervention's decision aid (importance of early detection, concern about radiation, concern about false alarms, and concern about overdiagnosis). We also included an assessment of anticipated regret if screening was declined and lung cancer was later diagnosed. This variable was included because affective forecasting, which can be defined as an attempt to predict how a decision will make you feel in the future, has been shown as an important factor in patients' choices for screening and medical treatments.[13] Furthermore, anticipated regret has been shown as a predictor of health intentions and behavior as individuals are motivated to avoid feeling regret for their actions or inaction.[14]

Methods

Study Design

This is a secondary analysis of data from the intervention group of a randomized clinical trial conducted with 13 state tobacco quitlines' clients. The trial was approved by the institutional review board.

Setting

Participants were enrolled from March 2015 to September 2016; they were followed for 6 months (until May 2017). Only participants who were randomized to the intervention were included in the present study. The intervention tested a video-based decision aid in comparison with standard educational materials to assess the effect of the decision aid.[15] Full details of the trial, including its context and methods, are published elsewhere.[16] Data for the present study are drawn from a 1-week assessment, and the screening outcome was collected during the 6-month follow-up. Data were collected via telephone interviews, or by mail if participants were not able to be reached by telephone. In the main study, 235 (of 259) participants randomized to the intervention completed the 1-week follow-up and 218 completed the 6-month follow-up.

Participants

Eligible participants were quitline callers who met LCS eligibility requirements, including being between 55 and 80 years of age, a current or former (within 15 years) smoking history, with a minimum of 30 pack-years; they could read, understand, and write in English; and consented to be included in the trial. Information about comorbidities was not collected.

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Primary Outcome

This study's main outcome reflects whether participants had obtained LCS by the 6-month follow-up point and compares it with LCS intentions (1 = obtained LCS, 0 = did not obtain LCS). This was ascertained by a mailed survey.

Predictors

Independent variables were selected based on observations from prior qualitative research in order to represent factors that may be associated with LCS.[17–21]

Importance of Detecting Lung Cancer Early. In the 1-week follow-up, participants were asked, "On a scale from 0 to 10, where 10 means extremely important and 0 means not at all important, how important is it to try to find lung cancer early when it is potentially curable?"

Concern About Radiation. In the 1-week follow-up, participants were asked, "On a scale of 0 to 10 [. . .], how concerned are you about radiation exposure from lung cancer screening and potential follow-up testing?"

Concern About False Alarms. In the 1-week follow-up, participants were asked, "On a scale of 0 to 10 [. . .], how concerned are you that your scan says you have cancer when you do not (in other words, a false-alarm)? This would also mean having additional potentially harmful testing."

Concern About Overdiagnosis. In the 1-week follow-up, participants were asked, "Some lung cancers may never become life threatening, yet some people may be treated for lung cancer that would never have harmed them, this is called overdiagnosis. On a scale of 0 to 10 [. . .], how concerned are you about overdiagnosis?"

Anticipated Regret. In the 1-week follow-up, participants were asked to rate on a 0 to 10 scale, "If you made the decision not to be screened for lung cancer and you were later diagnosed with lung cancer, would you have regrets?"

Practical Considerations. Potential barriers to LCS were assessed in the 1-week follow-up with the following three items that were dichotomized (1 = yes, 0 = no, unsure): 1) "If you wanted to be screened, would you know where to go?" 2) "Do you know if your insurance covers lung cancer screening?" and 3) "If you had to pay for screening would you be able to? Assume a screening scan cost $200?"

Knowledge. Participants' knowledge was assessed with nine items from the LCS-12[22] and this analysis uses scores from the 6-month follow-up. These items were scored by computing the percentage of questions that were answered correctly. Due to the skew of data, the data were coded into the following dummy variables for analysis: low scores (11.11 [lowest score] to 44.44), average score (55.56, this is the reference group in the regression analysis [there are no scores between 44.44 and 55.56]), and high scores (66.67 to 100 [there are no scores between 55.56 and 66.67]).

Additional Control Variables. Participants' demographics, including age, educational attainment (i.e., some college or more), and having health insurance, were included in the analysis. Additionally, participants' intentions to obtain LCS at 1-week assessment following the intervention were included. Three dummy-coded variables to reflect smoking status at the 6-month follow-up (relapsed during study, quit smoking during study, still smoking throughout study, with quit prior to study as the reference variable for the regression analysis) were also included.

Analysis Plan

Data were skewed within some of the predictor variables. Due to the skewness and bimodal distributions of the variables, log transformation was not appropriate for this analysis.[23] In order to account for this, dummy variables were created as described below. This approach allowed us to examine more granular differences within the high and low levels of concern that were seen in responses.

Importance of Detecting Lung Cancer Early. Responses to the item (with ratings of 9 to 10) were highly skewed, and a dummy variable was created for responses of 10, and all other responses (0 to 9) as the reference group for the regression analysis.

Concern About Radiation. Three dummy variables were created with the following groupings: Very Concerned (responses of 9 and 10), Concerned (responses indicating 5 to 8), Semi-Concerned (responses indicating 1 to 4). The reference group in the regression analysis indicated 0 concern.

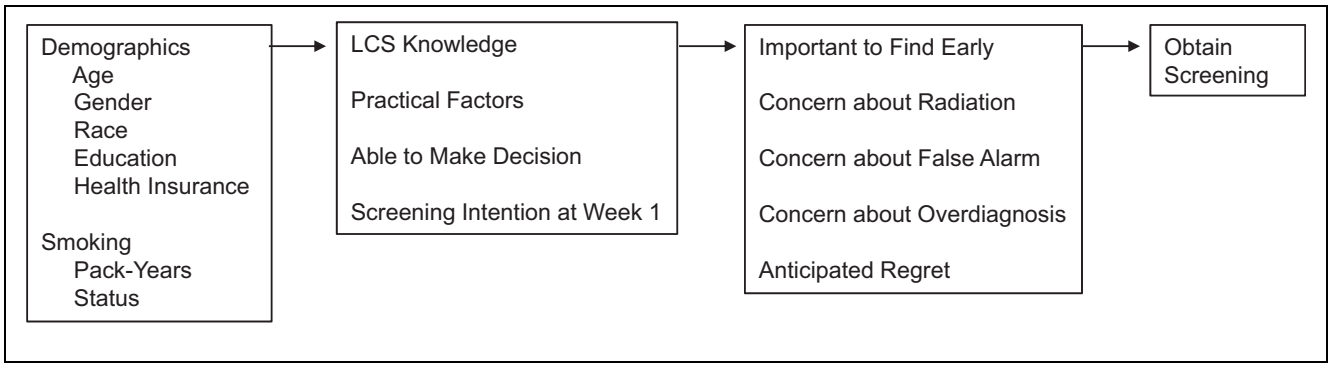

Figure 1 Hypothesized model.

Concern About False Alarms. Three dummy variables were created with the following groupings: Very Concerned (responses of 9 and 10), Concerned (responses indicating 5 to 8), Semi-Concerned (responses indicating 1 to 4). The reference group in the regression analysis indicated 0 concern.

Concern About Overdiagnosis. Three dummy variables were created with the following groupings: Very Concerned (responses of 9 and 10), Concerned (responses indicating 5 to 8), Semi-Concerned (responses indicating 1 to 4). The reference group in the regression analysis indicated 0 concern.

Anticipated Regret. One dummy variable (very concerned) was created for responses of 10; all lower responses (0 to 9) are in the reference group for the regression analysis.

Statistical Analysis

The data were analyzed in a logistic regression model with three blocks. This reflected the conceptual model that was guided by prior research findings (Figure 1). The predictors for the final model were selected with a seven-step process of purposeful model building.[24] This process was undertaken in order to select only the most important variables. The variables' correlations as well as VIF from a linear regression model was used in order to diagnose potential multicollinearity as recommended,[25,26] with no serious threats detected. The overall model fit was assessed, and standardized residuals examined to detect outliers; four cases that were misclassified were deleted (one had discovered ineligibility for screening while discussing with health care provider; three had been inactive through portions of the study [3-month follow-up] and were missing data). The analyses were conducted in SPSS (v. 24).

Results

Descriptive Data

Participants' (n = 204, after deleting the 4 outliers) mean age was 61.39 years (SD = 4.92), and the mean pack-years smoking history was 53.61 pack-years (SD = 23.79). The majority of participants were White (69.6%), and more than 50% of the sample had completed some college or higher levels of education. A summary of descriptive statistics is provided in Table 1.

LCS Completion by the 6-Month Follow-up

At 1 week following the intervention, a small portion of participants reported low intentions to obtain LCS (n = 24, 11.8%). At the 6-month time point, 62 (30.4%) participants had obtained LCS.

Predictors of Obtained LCS

The regression model had good fit overall (Hosmer-Lemeshow χ^2 = 8.14, P = 0.42; Nagelkerke R^2 = 0.37).

Regarding practical barriers, the results showed a positive association between each of the variables that were assessed and obtaining LCS. Specifically, compared with those who did not know where to go, individuals who knew where to go for LCS at 6 months were more likely to have been screened (odds ratio [OR] = 5.67, 95% confidence interval [CI] = 1.56–20.58). Similarly, participants who knew if their insurance covered screening were more likely to have obtained LCS at 6 months compared with those who did not know (OR = 4.73, 95% CI = 2.15–10.41).

Table 1 Participant Characteristics

	***n* (%)**
Outcome	
LCS obtained by 6 months	62 (30.4%)
Demographics	
Female	121 (59.3%)
Age, mean (SD)	61.39 (4.92)
American Indian or Alaska Native	3 (1.5%)
Black or African American	54 (26.5%)
Hispanic or Latino	5 (2.5%)
White	142 (69.6%)
Education	
Less than high school	33 (16.2%)
High school/GED	57 (27.9%)
Some college	80 (39.2%)
College or more	34 (16.7%)
Practical considerations	
Have health insurance	187 (91.7%)
Know where to go for LCS	160 (78.4%)
Know if insurance covers LCS	101 (49.5%)
Would pay $200 for screening	89 (43.6%)
Smoking history	
Pack-year history, mean (SD)	53.61 (23.79)
Smoking: Relapsed during study	6 (2.9%)
Smoking: Quit during study	49 (24.0%)
Smoking: No change during study	123 (60.3%)
Smoking: Quit before study[a]	26 (12.7%)
Ability, intention, and knowledge	
No LCS intention at T2	24 (11.8%)
Able to make LCS decision	193 (94.6%)
LCS knowledge: Low scores (11.11–44.44)	101 (49.5%)
LCS knowledge: Average scores (44.45–55.56)[a]	53 (26.0%)
LCS knowledge: High scores (>55.56)	50 (24.5%)
Screening-related values	
Find early: Very important (10 = 1)	179 (87.8%)
Find early: Other responses (0–9 = 1)[a]	25 (12.3%)
Radiation exposure: Very important (9–10 = 1)	54 (26.5%)
Radiation exposure: Important (5–8 = 1)	69 (33.8%)
Radiation exposure: Other responses (0–4 = 1)[a]	81 (39.7%)
False alarm: Very important (9–10 = 1)	91 (44.6%)
False alarm: Important (5–8 = 1)	75 (36.8%)
False alarm: Other responses (0–4 = 1)[a]	38 (18.6%)
Over diagnosis: Very important (9–10 = 1)	99 (48.5%)
Over diagnosis: Important (5–8 = 1)	72 (35.3%)
Over diagnosis: Other responses (0–4 = 1)[a]	33 (16.2%)
Anticipated regret: Very important (10 = 1)	151 (74.0%)
Anticipated regret: Other responses (0–9 = 1)[a]	53 (26.0%)

LCS, lung cancer screening.
[a]Reference category in analysis.

High (OR = 0.17, 95% CI = 0.04–0.65) and Moderate (OR = 0.15, 95% CI = 0.05–0.53) levels of concern about overdiagnosis were associated with not obtaining LCS when compared with those who indicated low concern about this risk. In contrast, a high level of anticipated regret is associated with an increased likelihood of obtaining LCS compared with lower levels (OR = 5.59, 95% CI = 1.72–18.10). No other statistically significant association were observed (Table 2).

Table 2 Factors Associated With Obtaining Lung Cancer Screening

		95% CI	
	OR	**Lower**	**Upper**
Exogenous variables			
Age	0.99	0.91	1.08
Some college or more	0.92	0.41	2.06
Have health insurance	0.73	0.16	3.31
Pack-year history	1.00	0.99	1.02
Smoking: Relapsed during study	0.89	0.09	8.71
Smoking: Quit during study	0.52	0.15	1.82
Smoking: No change during study	0.37	0.11	1.19
Practical considerations			
Know where to go for LCS	5.67*	1.56	20.58
Know if insurance covers LCS	4.73***	2.15	10.41
Would pay $200 for screening	0.82	0.39	1.74
Ability, intention, and knowledge			
No LCS intention at T2	0.46	0.12	1.77
Able to make LCS decision	0.32	0.06	1.68
LCS knowledge: Low scores (11.11–44.44)	1.68	0.68	4.17
LCS knowledge: High scores (>55.56)	0.68	0.23	1.97
Screening-related values			
Find early: Very important (10 = 1)	0.55	0.15	2.06
Radiation exposure: Very important (10 = 1)	1.56	0.54	4.47
Radiation exposure: Important (5–8 = 8)	1.73	0.66	4.57
False alarm: Very important (9–10 = 1)	1.98	0.55	7.13
False alarm: Important (5–8 = 1)	2.25	0.65	7.78
Over diagnosis: Very important (9–10 = 1)	0.17*	0.04	0.65
Over diagnosis: Important (5–8 = 1)	0.15***	0.05	0.53
Anticipated regret: Very important (10 = 1)	5.59***	1.72	18.10
Constant	0.51		

LCS, lung cancer screening.
*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

Discussion

In this study, we aimed to identify predictors associated with obtaining LCS within 6 months of a decision aid intervention. Approximately one third of participants had obtained LCS by this point. This was lower than pulmonary care settings but higher than some national estimates; further discussion is presented with the main study.[16] Our results show two main areas of association with obtaining LCS. First, we observed that not having practical barriers (i.e., knowing where to go for LCS and knowing if insurance covered LCS) was associated with an increased likelihood of having obtained LCS. Second, beliefs toward LCS were also associated with behavior. Specifically, concern about overdiagnosis was associated with a lower likelihood of having obtained LCS. Conversely, anticipated regret about declining screening and later being diagnosed with lung cancer was associated with about six times higher likelihood of having obtained LCS.

However, responses regarding false alarms, radiation exposure, and believing that finding lung cancer earlier due to screening were not associated with LCS behavior; each of these areas of consideration was included in the decision aid intervention. There has been concern about SDM hindering LCS uptake.[27,28] Prior work has shown that use of decision aids and SDM typically results in higher decision quality.[12] Indeed, the main study's results showed that intervention participants scored higher on knowledge assessments than those in the standard education group.[16] Within the present study, perceived importance of most LCS harms and benefits that are elucidated in the patient decision aid were not significant. Specifically, in the decision aid, overdiagnosis was presented along with the other potential harms of LCS. It was explained as diagnosing a cancer that would not have been life-threatening and that some people may be treated for a cancer that would not have done harm in their lifetime. Anticipated regret was not directly addressed in the decision aid. Rather, viewers were

invited to consider what aspects of screening are most important for their situations.

Interestingly, risk factors such as age and pack-year smoking history were not associated with screening. Similarly, screening intention at the 1-week follow-up was also not associated with LCS behavior. These results suggest that a mix of factors are associated with LCS uptake.

Our findings that concern about overdiagnosis align with prior work examining barriers to LCS uptake. For instance, approximately one third of participants in one study reported hesitancy to find out if they had lung cancer.[29] Furthermore, a multilevel examination of barriers to LCS suggests that patient-level fear of diagnosis veracity and provider-level barriers related to limited and misinformation about the screening process and effectiveness hinder uptake.[30]

Less work has examined anticipated regret specifically related to LCS. However, a meta-analysis of anticipated regret and health behavior suggests that anticipated regret is associated with both intentions and health behaviors.[14] This aligns with results of a meta-analysis examining affective forecasting in medical screening and treatment decisions.[13] Furthermore, anticipated regret from not engaging in a behavior ("inaction regret") has been shown as a predictor of stronger intentions and behavior.[14] Similarly, guidance for developing cancer risk messages suggests using loss-based messages to encourage screening behavior based on risk perception research.[31] Our findings align with this perspective.

Finally, prior work has suggested that concerns about practical barriers affect LCS uptake.[32,33] Our findings regarding knowing where to go and knowing if insurance covers LCS are in line with this concern. It is noteworthy that most of our assessments were collected during the 1-week follow-up after exposure to the patient decision aid. The timing of data collection would have allowed most participants to have a relatively fresh recollection of information regarding potential harms and benefits of LCS. In contrast, participants who were interested in obtaining screening may not have had enough time to learn about practical considerations such as insurance coverage or screening locations.

Limitations

As is the case with all research, there were some limitations. First, the participants had called quitlines and may have different attitudes toward health-related behaviors such as LCS than other persons with a heavy smoking history.[34,35] However, our study may shed light on predictors of LCS among individuals who are considering smoking cessation. Similarly, more than half of the participants had completed some college. However, education was not significantly associated with outcomes in the present study or in the main study.[16] Second, the variables that were included in this analysis were assessed with single items; thus, our measures may be less reliable than if we had access to a full scale. However, the results of our secondary analysis suggest there are associations between individual-level predictors and LCS. Finally, although the participants were followed for 6 months, a longer time period would have been ideal to assess both uptake and subsequent adherence to annual screening.

Conclusion

We identified several factors associated with an increased likelihood of obtaining LCS, including knowing where to go, if insurance covers screening, and anticipated regret about a later diagnosis. Concern about overdiagnosis was negatively associated with obtaining LCS by 6 months. Our results highlight the importance addressing patient concerns such as overdiagnosis and anticipated regret in decision making.

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ORCID iDs

Kristin G. Maki https://orcid.org/0000-0003-2980-7118
Lisa M. Lowenstein https://orcid.org/0000-0003-3481-5980
Robert J. Volk https://orcid.org/0000-0001-8811-5854

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