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Risk Perceptions Among Participants Undergoing Lung Cancer Screening: Baseline Results from the National Lung Screening Trial

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Abstract

Background—Lung cancer screening could present a “teachable moment” for promoting smoking cessation and relapse prevention. Understanding the risk perceptions of older individuals who undergo screening will guide these efforts.

Purpose—This paper examines National Lung Screening Trial (NLST) participants’ perceptions of risk for lung cancer and other smoking-related diseases. We investigated (1) whether risk perceptions of lung cancer screening participants differed between current and former smokers and (2) which factors (sociodemographic, smoking and medical history, cognitive, emotional, and knowledge) were associated with these risk perceptions.

Methods—We analyzed baseline data collected from 630 NLST participants prior to their initial screen. Participants were older (55–74 years), heavy (minimum 30 pack years) current or former smokers. A ten-item risk perception measure was developed to assess perceived lifetime risk of lung cancer and other smoking-related diseases.

Results—The risk perception measure had excellent internal consistency ($\alpha=0.93$). Former smokers had lower risk perceptions compared to current smokers. Factors independently associated with high risk perceptions among current smokers included having a personal history of a smoking-related disease, higher lifetime maximum number of cigarettes smoked daily, having lived with a smoker, high worry, high perceived severity of lung cancer and smoking-related diseases, and accurate knowledge of tenfold increased risk of lung cancer for a one pack per day smoker. Factors

independently associated with high risk perceptions among former smokers included being White, past history of smoking within 30 min of waking, high worry, and accurate knowledge of tenfold increased risk of lung cancer for a one pack per day smoker.

Conclusions—Using a comprehensive risk perception measurement, we found that current and former smokers held different risk perceptions. Former and current smokers' smoking and medical history, race, emotional concerns, behavior change cognitions, and knowledge should be considered during a prescreening risk communication session. We highlight the theoretical and risk communication implications for former and current smokers undergoing lung cancer screening.

Keywords

Risk perceptions; Lung cancer; Cigarette smoking

Introduction

Cigarette smoking is responsible for 87% of lung cancers [1,2]. Compared to a never smoker, the relative risk of lung cancer is 10 for a one pack per day male smoker; it increases to 25 for a two pack per day smoker [3]. Smoking cessation has health benefits that increase with duration of abstinence, but even after 10 years of abstinence, former smokers are at increased risk of lung cancer and other smoking-related diseases (SRDs) compared with never smokers [4]. Approximately half of all continuing smokers die prematurely, losing on average 13–15 years of life [5].

Patients diagnosed with lung cancer have a poor prognosis; fewer than 20% survive 5 years after diagnosis [6,7], but Henschke and others have proposed that detecting lung cancers at earlier, more treatable stages using spiral computed tomography (CT) screening will reduce lung cancer mortality [8,9]. “Teachable moments” for health promotion activities are hypothesized to occur during cancer care [10]. Although much of the research in this area has focused on smoking cessation following a cancer diagnosis [11–16], lung cancer screening may also be a teachable moment in which to promote smoking cessation among current smokers and reinforce relapse prevention among former smokers [17]. Undergoing lung cancer screening may change cancer-related risk perceptions, an intermediate step that facilitates smokers' intentions and motivation to quit [18–21]. However, to date, no one has comprehensively measured or examined the risk perceptions of older individuals who seek lung cancer screening.

Smokers' risk perceptions are not well understood. There is no agreement on how smokers view their risks; this lack of agreement is likely due to the variability in how risk perceptions and outcomes are measured. Although some researchers have reported that smokers overestimate the health risks of smoking [22–24], others have found that smokers have an accurate or underestimated perception of their risk [25–30]. Smokers may display an optimistic distortion when they are asked to rate their own risk of acquiring a SRD compared to the “average smoker” or “other smokers” [31–35]. One study examined risk perceptions of older (50–72 years), heavy smokers and found that they underestimated their risks of premature mortality, cancer, and heart disease [25].

There are many benefits to smoking cessation for older patients. At age 60 and over, cessation can decrease rates of smoking-induced disease [36]. Within 2 years of quitting, smokers who quit after 65 years of age reduce their risk of death compared to current smokers. Smoking cessation in older adults decreases the risk of coronary events (within 1 year of quitting) and smoking-related cancers (within 5 to 10 years of quitting) [37]. However, few smoking cessation and relapse prevention studies have been conducted with older smokers.

The research that has been done with older smokers shows promise for cessation interventions with this population. Studies of smoking patterns and attitudes among older, heavy smokers found that most intend to quit in the next year [38], and 42% make an annual 24-h quit attempt [39]. Compared to younger smokers, older smokers are more likely to be successful if they attempt to quit [36] and are more likely to utilize smoking cessation assistance [40,41]. A recent study demonstrated that 19% of smokers 65 years and older who were provided with a telephone quitline and low-cost pharmacotherapy were able to quit smoking and maintain their quit at 12-month follow-up [42]. An observational study of smokers' behaviors following CT screening found that older age was associated with smoking abstinence at 12-month follow-up; there was a 25% abstinence rate in the oldest age group (70 years and over), compared to a 12% abstinence rate in the youngest age group (50–54 years) [20].

We examined prescreening lung cancer risk perceptions among older current and former heavy smokers participating in the National Lung Screening Trial (NLST) to inform future work using lung cancer screening as a teachable moment for promoting cessation and preventing relapse. We developed a questionnaire based on theoretical cognitive and emotional components from the Health Belief Model (HBM) [43], the Precaution Adoption Process Model [44], and the Self-Regulation Model [45]. The HBM [46,47] states that individuals are more likely to make a preventive behavior change such as quitting smoking if they feel the threat is serious, they are at risk, they are confident that they could make a change, and they believe that making a change would be beneficial. The theory further posits that a “cue to action,” such as screening for lung cancer, can stimulate the behavior change process. Previous research has documented that intentions to quit are directly influenced by risk perceptions [48,49]. Weinstein's Precaution Adoption Process Model (1988) builds on the HBM by outlining the stages that individuals pass through before making a preventive behavior change; an individual must become aware of the health threat, believe that it poses a threat to others, believe that it poses a threat to himself or herself (in other words, overcome their optimistic bias), and then decide whether to take a precaution (e.g., change behavior). The Self-Regulation Model extends beyond the HBM to integrate emotional, as well as cognitive, responses to a threat. It posits that when a health threat is presented, two processes in health behavior change occur: (1) cognitive processes that construct beliefs about the illness and develop a plan of how to cope with it (e.g., risk perceptions of lung cancer and perceived benefits of coping with it) and (2) emotional processes involving fear and arousal (e.g., worry).

Our main objectives were to investigate (1) whether risk perceptions of lung cancer screening participants differed between current and former smokers and (2) which factors (sociodemographic, smoking and medical history, cognitive, emotional, and risk knowledge) were associated with these risk perceptions. Study findings will facilitate a better understanding of the components of risk perceptions, and this information can be used to enhance risk communication cessation interventions for current and former smokers who are undergoing lung cancer screening. This study is novel in that we (1) developed a comprehensive, multi-item measure of risk perceptions that included personal and comparative risk questions for lung cancer as well as SRD outcomes, (2) assessed behavior change constructs and knowledge among an older, high risk population, and (3) conducted assessments that captured risk perceptions prior to lung cancer screening.

Methods

Design

This cross-sectional study examined lung cancer and other SRD risk perceptions among a subset of participants of the NLST. The NLST is a collaboration between the American College of Radiology Imaging Network (ACRIN) and the National Cancer Institute Lung Screening Study. The NLST randomly assigned more than 54,000 participants at 33 sites to be screened

with either spiral CT or chest X-ray. These participants are being followed for up to 8 years to determine whether there is a difference in lung cancer mortality between the two screening arms. Should lung cancer mortality be reduced in the CT arm of the trial, CT screening might become the standard of care.

Participants and Data Collection

The National Cancer Institute launched a national campaign when the ACRIN/NLST study began. The Cancer Information Services, an NCI in-house resource, developed a study eligibility protocol to screen potential participants who called in response to the media campaign. Recruitment efforts included public service announcements on local radio stations, advertisements in local newspapers, and communication with individual physicians and physician practices. All interested individuals were screened, over the telephone, for eligibility. At the time of recruitment into the trial, participants were 55–74 years of age, current or former (quit within the past 15 years) smokers with a history of 30 pack years or more, had no history of lung cancer, had not been treated for any cancer within the past 5 years other than a non-melanoma skin cancer, and were not participating in any other screening or cancer prevention trial.

Permission was obtained from the ACRIN/NLST executive committee to administer this questionnaire as a sub-study within the ACRIN arm of the trial. Twenty-three ACRIN study sites participated in the ACRIN arm of the NLST; eight sites opted to participate in this sub-study (Appendix). From December 2003 to March 2004, all trial enrollees at the eight sub-study participating sites completed our study questionnaire as part of the trial prescreening baseline questionnaire battery.

Pilot Work

Prior to trial administration, the study questionnaire was cognitively tested with 15 participants from the Brown University ACRIN site. Participants were asked if questions were (1) confusing, (2) difficult to answer (because of response categories), (3) repetitive, and (4) upsetting. The questionnaire was revised, based on these pilot results, and included changes to item wording (e.g., “such as emphysema, stroke, and heart disease” was added after “other than lung cancer” to clarify the term “smoking-related diseases”), item placement, item additions, response category options, and formatting (e.g., removal of unnecessary section headings and form formatting changed to match other trial forms). Institutional Review Board approval to administer the questionnaire was obtained from Partners Healthcare and all eight participating study sites.

Measures

ACRIN/NLST Baseline Sociodemographic, Medical, and Smoking History Variables—The trial baseline questionnaires [50] include measures on sociodemographics (age, education, gender, household income, marital status, and race/ethnicity), smoking history (smoking status, number of years quit, number of years smoked, highest number of cigarettes smoked per day, smoked within 30 min of waking, quit attempt in the past year, lived with a smoker, worked with a smoker, occupation with hazardous exposure, and smoking intentions), and medical history (personal history of cancer or SRD, family history of lung cancer, and experiencing cough or shortness of breath). Intentions to quit/stay quit were assessed on a 10-point scale with items ranging from, “I enjoy smoking so much I will never consider quitting no matter what happens” to “I have quit and I am 100% confident that I will never smoke again” [51].

Risk Perception Sub-study Questionnaire—Using constructs from behavior change theories, we developed a 25-item questionnaire. The questionnaire included risk perception

items and theoretically based cognitive and emotional behavior change constructs. We also included knowledge of smoking risks questions; Kreuter and Strecher posited that in order to understand the risk perception biases of an individual, it is necessary to also assess and incorporate an individual's knowledge about smoking risks [52]. We built upon previously published measures of these cognitive and emotional constructs. Questions appeared in the following order: risk perceptions [53–55], knowledge of smoking risks [23,24,27,52], worry [53,56], self-efficacy to quit smoking/stay quit [57], perceived benefits of quitting smoking [53,58], and perceived severity [59].

Risk Perceptions: An individual's risk perception profile is constructed based on his/her views of his/her personal and comparative risk. Since each informs and influences the other, we captured individuals' personal risk reports (own risk) as well as their comparative risk reports (risk in relation to others). Since SRDs are also likely to be detected from screening, we asked about risk of SRDs, as well as risk of lung cancer. *Risk perceptions* were assessed from ten questions. To assess perceived personal risk, we posed four questions on a 5-point Likert scale about the likelihood (very unlikely to very likely) and danger (strongly disagree to strongly agree) of developing lung cancer and a SRD. Perceived comparative risk was assessed from six questions presented on a 5-point Likert scale. Since risk perceptions differ based on how individuals are asked and who is in the comparison group [27,29,53–55,58], comparative risk was assessed with three different referent groups. Participants were asked if they were in danger of developing lung cancer and other SRDs, compared to the *average person* (strongly disagree to strongly agree). Participants were also asked about their chances of developing lung cancer and a SRD, compared to *others of the same age and sex* and *other former/current smokers* (much lower to much higher).

Knowledge, Cognitive, and Emotional Constructs Knowledge of smoking risks was assessed by three questions asking participants to quantify a smoker's risk of developing lung cancer ("A smoker who smokes one pack of cigarettes a day is at how many times risk of developing lung cancer, compared to a nonsmoker?") and the number of years of life lost due to smoking ("On average, smokers die nearly _____ years earlier than nonsmokers."). In addition, participants were asked about the percentage of smokers who would get lung cancer ("Among 100 smokers, how many will get lung cancer because they smoke?"). Worry about lung cancer and other SRDs was assessed by four questions about intensity (4-point Likert scale, not at all to extremely) and frequency of worry (4-point Likert scale, not at all to all of the time); items were combined to create a single score (range=4–16; alpha=.89). *Self-efficacy* was measured by one question about level of confidence to quit smoking/remain quit (5-point Likert scale, not at all to extremely). *Perceived benefits of quitting smoking* was measured by three questions about the benefits of quitting in terms of decreasing risk for lung cancer and other SRDs and increasing life expectancy (4-point Likert scale, not at all to very much); these items were combined to create a single score (range=3–12; alpha=0.89). *Perceived severity* was assessed by four questions about the health consequences and severity of lung cancer and other SRDs (5-point Likert scale, not at all to extremely); these items were combined to create a single score (range 4–20; alpha=0.85).

Analysis

Statistical analyses were conducted using SPSS 16.0 statistical software. Current and former smokers were compared with respect to sociodemographics, smoking history, medical history, knowledge of smoking risks, risk perceptions, and cognitive and emotional behavior change constructs; chi-square and Fisher's exact tests were used for categorical variables, analysis of variance for continuous variables, and Kruskal–Wallis for ordinal variables. The internal consistency of the risk perception outcome variable was assessed by calculating Cronbach's alpha. Univariate analyses were run (analysis of variance for categorical variables, Pearson

correlation for continuous variables, and Spearman rank for ordinal variables) to test for associations between the risk perception outcome variable and sociodemographics, smoking history, medical history, risk knowledge, and cognitive and emotional behavior change constructs. Factors associated with the risk perception outcome variable at $p \leq 0.10$ level in the univariate analyses are included in the table; two linear regression models were run, one for current smokers and one for former smokers. Spearman rank tests were run to examine the association between smoking behavior intentions and the risk perception outcome variable.

Results

Participant Characteristics

The study sample consisted of 630 ACRIN/NLST participants; 55% were current smokers (Table 1). Former smokers were older, more likely to be male and White, less likely to be among the lower income brackets, and more likely to be married. On average, former smokers had stopped smoking 7.1 years prior ($SD=4.9$), and 42.6% of current smokers had made an intentional 24-h quit attempt in the past year (Table 2). Former smokers had smoked for an average of 45 years ($SD=5.7$), and current smokers had smoked for an average of 43 years ($SD=5.4$; $p < 0.001$). Former and current smokers did not differ on medical history variables, with the exception that 70.4% of current smokers, compared to only 51.6% of former smokers, experienced smoking-related symptoms such as a cough or shortness of breath ($p < 0.001$).

Risk Perceptions and Behavior Change Constructs

The ten-item smoking risk perceptions measure possessed excellent internal consistency ($\alpha=0.93$). The risk perception total scores were summed; the mean total score was 35.2 [$SD=7.5$; range=10 (low) to 50 (high)] (Table 3). Compared to former smokers, current smokers had higher risk perceptions [means=36.9 (CS) and 33.1 (FS) respectively, $p < 0.001$] and greater worry about lung cancer and SRDs [range=4–16; means=9.8 (CS) and 8.9 (FS) respectively, $p < 0.001$]. Compared to current smokers, former smokers were more confident that they could remain quit [range, 1–5; means=4.6 (FS) and 2.7 (CS) respectively, $p < 0.001$] and believed in greater perceived benefits from quitting [range, 3–12; means=9.8 (FS) and 9.0 (CS) respectively, $p < 0.001$]. Former smokers endorsed greater perceived severity of lung cancer and SRDs, compared to current smokers [range, 4–20; means 18.6 (FS) and 18.1 (CS) respectively, $p < 0.01$].

Knowledge of Smoking Risks

Both current and former smokers overestimated lung cancer prevalence among smokers; they estimated that approximately 40% of smokers would get lung cancer (Table 3). However, both current and former smokers underestimated other risks of smoking; current smokers were even more likely to do so. The majority of former and current smokers underestimated average years of life lost for smokers; only 18% of former smokers and 10% of current smokers accurately responded that smokers die greater than 10 years earlier than nonsmokers. Forty percent of current smokers and 28% of former smokers believed that a pack a day smoker had minimal (0–2 \times) elevated risk of lung cancer attributable to smoking; only 34% of current smokers and 37% of former smokers accurately identified the tenfold or greater risk for lung cancer.

Multivariable Analyses of Factors Associated with Risk Perceptions

In the multivariable analyses, we built separate models for current and former smokers (Table 4). The model for current smokers yielded six significant correlates of risk perceptions. Factors that were independently associated with high risk perceptions among current smokers were having a personal history of a SRD ($\beta=0.16$, $SE=0.78$, $p=0.001$), higher lifetime maximum number of cigarettes smoked daily ($\beta=0.18$, $SE=0.02$, $p < 0.001$), having lived with a smoker

($\beta=0.10$, $SE=1.17$, $p=0.04$), high worry ($\beta=0.38$, $SE=0.15$, $p<0.001$), high perceived severity of lung cancer and SRDs, ($\beta=0.11$, $SE=0.17$, $p=0.04$), and accurate knowledge of tenfold increased risk of lung cancer for a one pack per day smoker (0–2× risk compared to 10× risk; $\beta=-0.19$, $SE=0.95$, $p=0.003$). The model for former smokers yielded four significant correlates of risk perceptions. Factors that were independently associated with high risk perceptions among former smokers were being White ($\beta=-0.20$, $SE=0.99$, $p<0.001$), smoked within 30 min of waking ($\beta=0.18$, $SE=0.80$, $p=0.001$), high worry ($\beta=0.48$, $SE=0.16$, $p<0.001$), and accurate knowledge of tenfold increased risk of lung cancer for a one pack per day smoker (0–2× risk compared to 10× risk; $\beta=-0.18$, $SE=1.02$, $p=0.006$).

Smoking Risk Perceptions and Behavioral Intentions

Risk perceptions were associated with intentions to quit/stay quit ($p<0.001$ overall; within current smokers, $p<0.002$; within former smokers, $p<0.01$; Fig. 1). The relationship appeared curvilinear; the lowest risk perceptions were among current smokers who would never consider quitting (mean=29.1), and risk perceptions were the highest among current smokers who were planning on quitting in the next 30 days (38.3). Among former smokers, those who were confident that they would not relapse had lower risk perceptions (mean=32.6) compared to those who were concerned about relapse (35.9).

Discussion

This study was designed to understand how older current and former heavy smokers who undergo lung cancer screening perceive their risk of lung cancer and other SRDs. We developed a comprehensive risk perceptions measure that examined whether risk perceptions of lung cancer differed among participants who were current versus former smokers and examined factors associated with risk perceptions.

We developed a ten-item risk perception measure that queried both personal and comparative risk for lung cancer and SRDs, had high internal consistency, and was associated with smoking intentions. Similar to work conducted by Weinstein and colleagues in 2005 [30], current smokers with quitting intentions had higher perceived risk than smokers who did not plan on quitting. In the next phase of our work, through longitudinal analyses of these data, we will ascertain whether these intentions translate into actual behaviors.

Most research examining smokers' risk perceptions has used nonsmokers as a comparison group and deemed that smokers underestimate their lung cancer risk relative to nonsmokers [30,55]. However, some studies have compared risk perceptions of current versus former smokers and have yielded mixed results as to whether current smokers have higher or lower risk perceptions compared to former smokers [28,32,58,60,61]. Using our risk perception measure, we found that current smokers' risk perceptions were higher than those of former smokers; this was true when group comparisons were made using the total risk perception measure and for each of the ten personal and comparative risk questions. Moreover, only approximately 10% of current smokers responded that their risk of getting lung cancer or a SRD was lower than that of other smokers. Therefore, this group of current, heavy smokers who undergo lung screening did not display an optimistic bias, as might have been expected based on previous research. These findings are also surprising in light of key work that suggests that heavy smoking and older age is associated with being more likely to underestimate risk [25,60,62]. Our results indicate that older individuals with a significant smoking history who seek out lung cancer screening might hold different perceptions than would be otherwise expected.

Although it is believed that perceived risk can drive behavior change [52], our finding that former, heavy smokers had lower risk perceptions than current, heavy smokers suggests that

changing behavior may drive perceived risk; quitting smoking likely lowered former smokers' risk beliefs. This finding is consistent with the risk reappraisal hypothesis [63] that posits that if a change is made to decrease disease risk, in turn, risk perceptions decrease subsequent to this behavior change. This raises the question whether formerly heavy smokers who are undergoing lung screening overestimate the risk reduction achieved from quitting, which is potentially indicative of optimistic bias.

According to the HBM, in order to make a behavior change, individuals must believe that smoking would lead to serious health consequences and that quitting smoking will reduce the likelihood of getting lung cancer or a SRD. Accordingly, former smokers, compared to current smokers, endorsed greater perceived severity for lung cancer and SRDs and believed in greater perceived benefits from quitting. Former smokers recognized the threat, took action, and believed that this change would be of benefit. This is consistent with research that has shown that current smokers, compared to former smokers, report fewer benefits of quitting [32,53, 59] and that older, continuing smokers in particular are pessimistic about the benefits of quitting smoking [53,64].

In examining factors associated with risk perceptions, our findings support the Self-Regulation Model in that they underscore the important role of emotional factors in driving risk perceptions. Although many behavior change models include only cognitive constructs, in our study, worry was a salient factor associated with risk perceptions of both current and former smokers. This finding is consistent with findings from breast and colon screening studies in which cancer-related worry was associated with perceived risk [65–67]. In the cancer screening literature, it is unclear if worry leads to or deters from seeking cancer screening [56,67–74] or if worry and risk, together, influence behavior [75]. Similarly, for patients undergoing lung cancer screening, it is unclear at which level worry would positively influence risk perceptions and post-screening health promotion behaviors.

Our results also indicated that knowledge of smoking risks was an important factor associated with risk perceptions for both former and current smokers. Current and former smokers who underestimated a 1 pack per day smoker's increased risk of lung cancer due to smoking had lower risk perceptions for lung cancer and SRDs. These findings are similar to previous research that demonstrated that smokers underestimate the impact on quality of life and disability from smoking [76,77].

Among former smokers, past history of smoking within 30 min of waking, a proxy measure indicating greater nicotine dependence, was associated with elevated risk perception. It is possible that, within former smokers, those who had a higher level of nicotine dependence feel less of a sense of control over their future health and thus feel at greater risk for diseases.

Among former smokers, being Black was associated with lower risk perceptions for lung cancer and SRDs. Although there is a dearth of research conducted on racial differences and smoking-related risk perceptions, one study conducted among 144 smokers found that Black smokers were more likely to underestimate their lung cancer risk, compared to nonsmokers, and were less likely to believe that quitting smoking would reduce their lung cancer risk [53]. A population-based study also reported that Blacks were less likely than Whites to perceive cancer risk [62]. Racial differences have been shown to influence lung cancer treatment decision making in that Black patients have lower rates of surgical treatment and are more likely to refuse surgery [78], even after access to care has been demonstrated [79]. Our results suggest that race could influence lung cancer risk perceptions, particularly for previously heavy smokers who quit smoking; this is an area for future research.

Some study limitations must be noted. The participants in this NLST sub-study are not representative of all older current or former heavy smokers. In this self-selected population of

trial participants, one would assume that worry and risk perceptions would be relatively high. This is a high-risk group of individuals with smoking histories of at least 30 pack years who elected to participate in a screening trial; this may have restricted the range of responses for the risk perception outcomes since, at high levels of smoking consumption, there are decreasing increments of risk [80]. The majority of NLST participants was White and had a fairly high education level. Lastly, about 25% of participants did not answer the question about smokers' years of life lost; perhaps it was a potentially uncomfortable question to quantify. Because of the missing data, and since this question was associated with the knowledge of a pack per day smoker's increased risk of lung cancer, it was not included in the multivariable model.

Our findings have important implications for prescreening risk assessments. We found that risk perceptions and risk knowledge among current and former heavy smokers is a complex issue, particularly when addressing risks for both lung cancer and SRDs; this implies that a prescreening assessment must include an assessment of both risk perception and risk knowledge. Our results also suggest that current, heavy smokers undergoing lung screening may not have an optimistic bias and, in fact, may be pessimistic about the value of quitting. Likewise, former, heavy smokers undergoing lung screening may benefit from reinforcement of the importance of staying quit. Therefore, prescreening comprehensive risk assessments would maximize the utility of lung screening as a teachable moment to promote smoking cessation and relapse prevention.

Once risk is assessed, prescreening risk communication sessions can be guided by the contextualized approach to risk communication [81]. The main features of this approach are that (1) information is provided on antecedents, (2) information is provided on consequences, and (3) information is given on how to minimize risk. Our findings indicate that, for lung cancer screening patients, *antecedents* to focus upon might be increasing recognition of risk due to an individual's smoking and medical history; care must be taken to do so in a way that would appropriately elevate worry. Our study showed that adverse *consequences*, such as smoking morbidity, might be an important area in which to focus and educate upon. For current smokers, *minimizing risk* could be done by emphasizing benefits to be gained by quitting and offering encouragement by sharing research on how older smokers successfully quit. This could be particularly salient for current smokers, given previous research that indicates their proclivity to diminish the benefits of quitting. For former smokers, *minimizing risk* could be done by supporting their quit status while including a cautionary note about the importance of maintaining quit and decreasing exposure.

In closing, this study demonstrated differences in risk perceptions and risk knowledge between current versus former smokers who were participating in NLST. Our results indicate that older, current heavy smokers who are undergoing lung cancer screening have higher risk perceptions compared to older, former heavy smokers. These findings suggest that lung cancer screening presents a unique opportunity to intervene with risk perceptions to potentially enhance smoking cessation and relapse prevention efforts in this group. As it is important to understand the determinants of risk perceptions in order to develop effective risk communication messages [81], this work elucidated the prescreening determinants of risk and emphasized the particular importance of assessing and discussing worry, risk knowledge, and perception of addiction prior to screening.

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Appendix

PARTICIPATING STUDY SITES

Brown University, Providence, Rhode Island

The Cancer Institute of New Jersey, New Brunswick, New Jersey

Mayo Clinic, Rochester, Minnesota

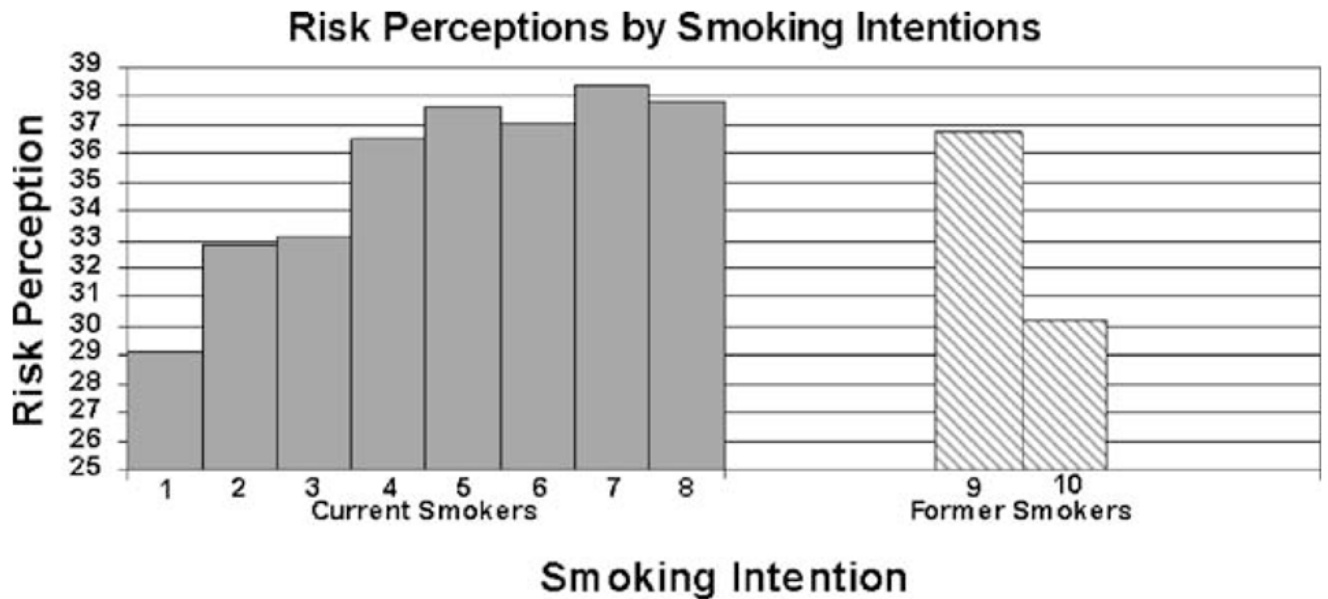
Dartmouth Hitchcock Medical Center, Lebanon, New Hampshire

St. Elizabeth Health Center, Youngstown, Ohio

Jewish Hospital Heart and Lung Institute, Louisville, Kentucky

Moffitt Cancer Center, Tampa, Florida

Johns Hopkins University, Baltimore, Maryland



- KEY**
- Current smokers:
 - 1: I enjoy smoking so much I will never consider quitting no matter what happens
 - 2: I never think about quitting but I might someday
 - 3: I rarely think about quitting and have no specific plans to quit
 - 4: I sometimes think about quitting but have no specific plans to quit
 - 5: I often think about quitting but have no specific plans to quit
 - 6: I plan to quit in the next 6 months
 - 7: I plan to quit in the next 30 days
 - 8: I have already begun to cut down and I have set a quit date
 - ▨ Former smokers:
 - 9: I have already quit but I worry about slipping back or relapsing
 - 10: I have quit and I am 100% confident that I will never smoke again

Fig. 1.
Risk perceptions by smoking intentions

Table 1

Sociodemographic characteristics of participants

	Total ever smokers (n=630)	Current smoker (n=345)	Former smoker (n=285)	p value
Age, mean (SD)	60.9 (4.9)	60.3 (4.6)	61.6 (5.2)	0.001
Female gender, <i>N</i> (%)	292 (46.3)	181 (52.5)	111 (38.9)	0.001
Education, <i>N</i> (%)				0.06
<HS graduate	57 (9.0)	35 (10.1)	22 (7.7)	
HS graduate/GED	189 (30.0)	115 (33.3)	74 (26.0)	
Post HS	207 (32.9)	110 (31.9)	97 (34.0)	
College and beyond	154 (24.4)	73 (21.2)	81 (28.4)	
Household income, <i>N</i> (%)				0.001
<\$15,000	79 (12.5)	55 (15.9)	24 (8.4)	
\$15,000–34,999	148 (23.5)	93 (27.0)	55 (19.3)	
\$35,000–64,999	178 (28.3)	82 (23.8)	96 (33.7)	
\$65,000 and above	140 (22.2)	80 (23.2)	60 (21.1)	
Marital status, <i>N</i> (%)				0.001
Married/living as married	398 (63.2)	197 (57.1)	201 (70.5)	
Widowed/divorced/separated	204 (32.4)	133 (38.6)	71 (24.9)	
Never married	25 (4.0)	15 (4.3)	10 (3.5)	
Race/ethnicity, <i>N</i> (%)				0.03
White	573 (91.0)	306 (88.7)	267 (93.7)	
Black	50 (7.9)	36 (10.4)	14 (4.9)	
Other	7 (1.1)	3 (0.9)	4 (1.4)	

Note that column “%” may not add up to 100% if missing data.

Table 2

Smoking and medical history

	Total ever smokers (n=630)	Current smoker (n=345)	Former smoker (n=285)	p value
Smoking history				
Smoked within 30 min of waking, N (%)	445 (70.7)	260 (75.4)	185 (65.1)	0.003
Quit attempt in the past year, N (%)	–	147 (42.6)	–	–
Highest number of cigarettes/day, mean (SD)	36.4 (16.2)	35.6 (15.4)	37.2 (17.0)	0.22
Number of years quit, mean (SD)	–	–	7.1 (4.9)	–
Number of years smoked, mean (SD)	44.1 (5.6)	43.4 (5.4)	45.0 (5.7)	<0.001
Ever lived with a smoker, N (%)	557 (88.4)	313 (90.7)	244 (85.6)	<0.05
Ever worked with a smoker, N (%)	575 (91.3)	310 (89.9)	265 (93.0)	0.17
Has occupational exposure, N (%)	222 (35.2)	122 (35.4)	100 (35.1)	0.94
Medical history				
Has family history of lung cancer, N (%)	138 (22.2)	84 (24.6)	54 (19.3)	0.12
Has personal history of cancer, N (%)	65 (10.3)	35 (10.1)	30 (10.5)	0.88
Has personal history of SRD, N (%)	168 (26.7)	96 (27.8)	72 (25.3)	0.47
Has cough or shortness of breath, N (%)	390 (61.9)	243 (70.4)	147 (51.6)	<0.001

Note that *SRD* indicates smoking-related disease.

Table 3

Behavior change constructs and knowledge of smoking risks

	Total ever smokers (n=630)	Current smoker (n=345)	Former smoker (n=285)	p value
Risk perceptions, mean (SD)				
Risk perceptions for lung cancer and SRDs	35.2 (7.5)	36.9 (7.3)	33.1 (7.1)	<0.001
Cognitive and emotional constructs, mean (SD)				
Perceived benefits of quitting smoking	9.4 (2.2)	9.0 (2.2)	9.8 (2.0)	<0.001
Confidence to quit smoking/remain quit	3.6 (1.4)	2.7 (1.1)	4.6 (0.8)	<0.001
Perceived severity of lung cancer and SRDs	18.3 (2.1)	18.1 (2.3)	18.6 (1.7)	0.01
Worry about lung cancer and SRDs	9.4 (2.9)	9.8 (2.9)	8.9 (2.7)	<0.001
Knowledge of smoking risks				
Percent smokers who will get lung cancer, mean (SD)	40.5 (23.3)	39.2 (23.6)	42.0 (23.0)	0.16
Average years decreased life for smokers, N (%)				0.08
0–5	142 (30.6)	75 (31.9)	67 (29.3)	
6–10	258 (55.6)	136 (57.9)	122 (53.3)	
11 and higher	64 (13.8)	24 (10.2)	40 (17.5)	
One pack/day smoker's risk of developing lung cancer, N (%)				0.01
0–2× risk	208 (34.4)	130 (39.5)	78 (28.4)	
5× risk	183 (30.3)	87 (26.4)	96 (34.9)	
10–20× risk	213 (35.3)	112 (34.0)	101 (36.7)	

Note that column “%” may not add up to 100% if missing data.

Note that *SRD* indicates smoking-related disease.

Factors associated with the risk perception outcome variable at $p \leq 0.10$ level in the univariate analyses were included in the multivariable analyses.

Table 4

Linear regression: factors associated with risk perceptions for lung cancer and smoking-related diseases (SRDs)

Variables	β	SE	<i>p</i> value
<i>Current smokers</i>			
Age	-0.04	0.08	0.37
Experience cough or shortness of breath	-0.02	0.78	0.75
Has personal history of SRD	0.16	0.78	0.001
Smoked within 30 min of waking	0.04	0.80	0.39
Highest number of cigarettes/day	0.18	0.02	<0.001
Has family history of lung cancer	0.08	0.84	0.11
Ever worked with a smoker	0.09	1.17	0.06
Ever lived with a smoker	0.10	1.17	0.04
Worry about lung cancer and SRD	0.38	0.15	<0.001
Perceived severity of lung cancer and SRD	0.11	0.17	0.04
Perceived benefits of quitting smoking	0.07	0.17	0.19
One pack/day smoker's risk of developing lung cancer (0–2× risk) ^a	-0.19	0.95	0.003
One pack/day smoker's risk of developing lung cancer (5× risk) ^a	-0.02	0.45	0.68
<i>Former smokers</i>			
Black race ^b	-0.20	0.99	<0.001
“Other” race ^b	-0.02	3.31	0.66
Experience cough or shortness of breath	0.01	0.80	0.82
Has personal history of SRD	0.07	0.92	0.22
Smoked within 30 min of waking	0.18	0.80	0.001
Number of years quit	-0.09	0.08	0.13
Has family history of lung cancer	0.08	1.01	0.15
Ever lived with a smoker	0.01	1.08	0.95
Worry about lung cancer and SRD	0.48	0.16	<0.001
Perceived severity of lung cancer and SRD	-0.04	0.24	0.45
Perceived benefits of quitting smoking	-0.08	0.22	0.18
Knowledge of increased risk of lung cancer (0–2× risk) ^a	-0.18	1.02	0.006
Knowledge of increased risk from 1 pack/day (5× risk) ^a	-0.11	0.46	0.08

Note that *SRD* indicates smoking-related disease^aReferent group=10–20× risk^bReferent group=White participants