Original Article

How are lung cancer risk perceptions and cigarette smoking related?—testing an accuracy hypothesis

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Background: Subjective risk perception is an important theoretical construct in the field of cancer prevention and control. Although the relationship between subjective risk perception and health behaviors has been widely studied in many health contexts, the causalities and associations between the risk perception of developing lung cancer and cigarette smoking have been inconsistently reported among studies. Such inconsistency may be from discrepancies between study designs (cross-sectional versus longitudinal designs) and the three hypotheses (i.e., the behavior motivation hypothesis, the risk reappraisals hypothesis, and the accuracy hypothesis) testing different underlying associations between risk perception and cigarette-smoking behaviors. To clarify this issue, as an initial step, we examined the association between absolute and relative risk perceptions of developing lung cancer and cigarette-smoking behaviors among a large, national representative sample of 1,680 U.S. adults by testing an accuracy hypothesis (i.e., people who smoke accurately perceived a higher risk of developing lung cancer).

Methods: Data from the U.S. Health Information National Trends Survey (HINTS) were analyzed using logistic regression and multivariate linear regression to examine the associations between risk perception and cigarette-smoking behaviors among 1,680 U.S. adults.

Results: Findings from this cross-sectional survey suggest that absolute and relative risk perceptions were positively and significantly correlated with having smoked >100 cigarettes during lifetime and the frequency of cigarette smoking. Only absolute risk perception was significantly associated with the number of cigarettes smoked per day among current smokers.

Conclusions: Because both absolute and relative risk perceptions are positively related to most cigarette-smoking behaviors, this study supports the accuracy hypothesis. Moreover, absolute risk perception might be a more sensitive measurement than relative risk perception for perceived lung cancer risk. Longitudinal research is needed in the future to investigate other types of risk perception-risk behavior hypotheses—the behavior motivation and the risk reappraisals hypotheses—among nationally representative samples to further examine the causations between risk perception of obtaining lung cancer and smoking behaviors.

Keywords: Risk perception; cigarette smoking; accuracy hypothesis; Health Information National Trends Survey (HINTS)

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Introduction

Subjective risk perception, defined as "one's belief about the likelihood or probability of harm, namely the probability that a health problem will be experienced if no precautions or behavioral changes occur (1)", is an important theoretical construct in the field of cancer prevention and control. Subjective risk perception is often measured by absolute risk perception and relative (comparative) risk perception. The former examines a person's perception of the likelihood that he or she will get a certain disease within a defined time period; the latter assesses how a person compares the likelihood that he or she will get a certain disease to the likelihood that similar others will get the disease over a defined time period (2-6).

Although the relationship between subjective risk perception and health behavior in general has widely been researched, the association between risk perception of acquiring lung cancer and cigarette smoking is unclear. Studies have suggested causal relationships between lung cancer risk perception and cigarette-smoking behaviors in positive, negative, and no significant directions (7-11). Moreover, instead of causality relations, some studies have simply reported a positive correlation between lung cancer risk perception and smoking probability (12-16), whereas other studies found different associations (17,18).

Such inconsistent and mixed findings may confuse researchers about the relationship between lung cancer risk perception and smoking behaviors. We propose that these mixed data may be due to readers' possible misinterpretations of the association between lung cancer risk perception and smoking behaviors in literature. This may also have resulted from discrepancies between study designs and the tested risk perception-risk behavior hypotheses as well as from differences in the hypothesized underlying associations between risk perception and behaviors among studies.

To elucidate the association between lung cancer subjective risk perception and smoking behaviors, it is important to understand three primary types of hypotheses that have been used to evaluate risk perception-risk behavior relationships: the behavior motivation hypothesis, the risk reappraisals hypothesis, and the accuracy hypothesis (10,19). Because these three risk perception-risk behavior hypotheses are based on different types of theories, testing each of them requires different study designs and statistical techniques. In particular, the behavior motivation hypothesis, comparable to the concepts of most health behavior theories (20), suggests that if people perceive that their risk of getting a disease is high, they will be more likely to adopt subsequent healthy behaviors. A longitudinal design is required to test the causal nature of this hypothesis. In contrast to the behavior motivation hypothesis, the risk reappraisals hypothesis is similar to emotion-based theories (21). It states that if people take or intend to take a protective behavior, they will further reduce risk perception. Due to causal relationships, assessing this hypothesis also needs a longitudinal design to collect both risk perception and health behavior data at multiple time points. Finally, the accuracy hypothesis solely tests the correlation between risk perception and risk behaviors. This hypothesis tests whether individuals' risk perception accurately reflects risk behaviors at the same time point (e.g., people who smoke have a heightened risk perception of getting lung cancer). Thus, researchers can employ a cross-sectional design to collect and evaluate both risk perception and protective behaviors data at the same single time point (10,19,22).

Given that most prior studies, which assessed the relations between lung cancer subjective risk perception and smoking behaviors, have adopted a cross-sectional design, assessing the accuracy hypothesis is the most appropriate approach for examining this kind of data and concluding the findings. Nevertheless, researchers have sometimes drawn implications from their data based on causal risk perception-risk behavior hypotheses (i.e., the behavior motivation hypothesis and the risk reappraisals hypothesis). As an initial step to address this issue, we demonstrated the examination of the accuracy hypothesis by analyzing a large national dataset—the 2005 U.S. Health Information National Trends Survey [HINTS 2005] dataset.

Our study will contribute to existing cancer prevention and control research not only by matching the hypothesis to the type of data, but also by helping better understand how individuals view the relationship between their perceived lung cancer risk and cigarette smoking. Moreover, compared to past research that restricted their samples to certain groups and measured one type of risk perception and a single smoking behavior, our study expands existing literature by analyzing a large sample drawn from the general public and by using multiple measures for both risk perceptions and smoking behavior. Specifically, previous studies have often restricted their samples to smokers, cancer patients, or other specific groups. This study examined a large and nationally representative sample of U.S. adults (18 years of age or older). Furthermore, we tested both absolute and relative risk perceptions to better capture the subjective risk perception. Lastly, we not only examined the most commonly used variable to assess smoking behaviors (i.e., having smoked at least 100 cigarettes in lifetime), but also evaluated two other variables

related to the amount of cigarette use (i.e., both the frequency of smoking and number of cigarettes smoked).

Methods

Dataset and study design

We analyzed the HINTS 2005 dataset, which was collected by the National Cancer Institute in the United States. Using a list-assisted random-digit-dial method to initially draw a random sample of telephone numbers from U.S. households, HINTS 2005 data were collected via both telephone interview and web-based survey. Hispanics and African Americans were oversampled. To adjust for the complex sampling method, data were weighted, and 5,586 U.S. adults (age ≥18 years) comprised the nationally representative sample. The adjusted response rate was 20.83% (23) (for details about the dataset, see the NCI's website—http://hints.cancer.gov/). In this study, we first excluded respondents with a personal history of lung cancer and those who were unable to respond to the survey in English, yielding a sample size of 5,105 respondents. Additionally, because one-third of the sample population was randomly selected to answer both subjective risk perception questions, only those selected respondents were included in the analyses. The final sample size consisted of 1,680 participants. This exempt secondary data study was approved by the research team's institutional review boards.

Measures

Subjective (absolute and relative) risk perceptions

Two items assessed respondents' subjective perceived risk of developing lung cancer. The absolute risk perception item asked: "How likely do you think it is that you will develop lung cancer in the future (very low, somewhat low, moderate, somewhat high, and very high)?" The relative risk perception item asked: "Compared to the average person your age, would you say that you are more likely, about as likely, or less likely to get lung cancer?"

Cigarette-smoking behaviors

We selected three questions from HINTS 2005 related to respondents' cigarette-smoking behaviors. The first question was whether participants had smoked at least 100 cigarettes in their entire lives. Those answering "yes" were asked a second question concerning how often they smoked cigarettes (every day, some days, or not at all). Those who reported smoking every day were then asked how many cigarettes they smoked per day on average.

Covariates

We selected covariates to test for inclusion in our models based on existing risk perception literature (24). These included age, gender, race/ethnicity, marital status, educational level, household income, family history of lung cancer, perceived health status, health care coverage, and use of health communication channels (e.g., frequency of reading health information in newspapers/magazines).

Statistical analyses

SUDAAN software Version 9.0 was used to perform all statistical analyses incorporating the dataset replicate sampling weights. We first examined descriptive statistics for all variables, including weighted frequencies and 95% confidence intervals. Binary logistic regression models were built to examine the associations between risk perceptions (i.e., absolute risk perception and relative risk perception) and whether participants had smoked at least 100 cigarettes in their entire lifetimes (yes *vs.* no). A chi-square test was used to determine statistical significance at an alpha level of less than 0.05. Because frequency of cigarette smoking was coded as more than two categories (i.e., every day, some days, and not at all), we used multinomial logistic regression with the Wald F test to assess the association between this variable and subjective risk perception. We utilized multivariate linear regression models to examine the relationship between risk perception and the continuous variable of number of cigarettes smoked per day. To construct the final regression models, we used Hosmer and Lemeshow's forward checking and backward elimination methods to select significant covariates based on the $P<0.20$ criterion (25-27).

Results

Sample characteristics

Table 1 shows the characteristics of the respondents. Among the 1,680 participants in the final sample, the mean age was 46.3 years (standard error =0.5). Respondents were mostly White, non-Hispanic (weighted percentage =77.2%), married/living with a partner (64.3%), had some health care coverage (89.0%), and about half (56.1%) were women. Less than half of the respondents rated their health status as being very good or excellent (39.5%). The majority of participants had a college-level education or greater (57.2%) and reported an annual household income of at least $50,000 (53.4%). One-fifth of respondents (20.0%) reported that they had a family history of lung cancer.

Table 1 Sample characteristics (n=1,680)

Characteristics	N	Weighted (%) (95% CI)
Family history of lung cancer		
Yes	311	20.0 (17.5–22.5)
No	1,307	80.0 (77.5–82.5)
Age	–	46.3 (0.5)†
Gender		
Male	541	43.9 (40.5–47.2)
Female	1,139	56.1 (52.8–59.5)
Race/Ethnicity		
Non-Hispanic white	1,362	77.2 (74.4–80.0)
Non-Hispanic black	139	10.3 (8.5–12.2)
Hispanic	60	3.7 (2.5–4.9)
Other	101	8.8 (6.4–11.2)
Marital status		
Married/living with a partner	959	64.3 (60.9–67.7)
Divorced/Separated/ Widowed	492	16.8 (14.8–18.8)
Never been married	218	18.9 (15.6–22.2)
Household income		
<$25,000	363	22.2 (19.7–24.7)
$25,000–$49,999	395	24.4 (21.5–27.2)
≥$50,000	696	53.4 (50.4–56.5)
Education		
≤ High school	653	42.8 (39.5–46.1)
≥ College	1,024	57.2 (53.9–60.5)
Perceived health status		
Excellent/Very good	740	39.5 (36.4–42.6)
Good/Fair/Poor	939	60.5 (57.4–63.6)
Health care coverage		
Yes	1,528	89.0 (86.9–91.0)
No	147	11.0 (9.0–13.1)

†, mean (standard error).

Subjective (absolute and relative) risk perceptions of lung cancer

Respondents generally had a low absolute risk perception of developing lung cancer. As shown in *Table 2*, 47% rated their risk as being very low with 22.6% as somewhat low and 18.4% as moderate. Only 12.1% of respondents rated their risk of getting lung cancer as being somewhat high or very high. Participants had a fairly low relative perceived risk of developing lung cancer. Almost 60% of respondents reported that they were less likely to get lung cancer compared to the average person their age, and 28.9% rated their risk as being similar to that of other people of the same age. Only 11.8% of respondents felt their risk of developing lung cancer was higher than others their age.

Cigarette-smoking behaviors

Nearly half (48.8%, n=822) of the respondents had smoked at least 100 cigarettes in their lifetimes. Among those people, 38.2% smoked every day, 9.8% smoked some days, and 52.0% reported that they did not smoke at all. Those who smoked every day (n=235) were subsequently asked the average number of cigarettes they smoked per day; the mean value was 16.5 cigarettes (SE =0.80, range, 1–60).

Relationships between subjective (absolute and relative) risk perceptions and cigarette-smoking behaviors

After controlling covariates in regression models, our study showed that having higher (both absolute and relative) risk perceptions of getting lung cancer was associated with a higher likelihood of having smoked at least 100 cigarettes in participants' lifetime (OR =2.82; 95% CI, 2.39–3.35 for absolute risk perception; OR =4.40; 95% CI, 3.38–5.73 for relative risk perception; see *Table 3*). Additionally, absolute risk perception was positively associated with the frequency of cigarette smoking among ever smokers (OR =3.94; 95% CI, 2.74–5.66 for smoking every day versus not smoking; OR =2.27; 95% CI, 1.63–3.15 for smoking some days versus not smoking). Similarly, there was a positive relationship between relative perception and the frequency of cigarette smoking among ever smokers (OR =3.65; 95% CI, 2.47–5.40 smoking every day versus not smoking; OR =2.04; 95% CI, 1.38–3.02 smoking some days versus not smoking).

For the association between subjective (absolute and relative) risk perceptions and the number of cigarettes respondents smoked per day among current smokers, however, the positive relationship was statistically significant for absolute risk perception (β=0.21; SE =0.06; 95% CI, 0.09–0.34),

Table 2 Absolute and relative risk perceptions of developing lung cancer among all respondents (n=1,680)

Risk perceptions	N	Weighted (%) (95% CI)
Absolute perceived risk†		
Very low	816	47.0 (43.8–50.2)
Somewhat low	355	22.6 (19.6–25.5)
Moderate	306	18.4 (16.4–20.5)
Somewhat high	115	7.9 (5.87–9.9)
Very high	56	4.2 (2.7–5.6)
Total	1,648	100 (100.0–100.0)
Relative perceived risk‡		
Less likely	996	59.3 (56.0–62.6)
About as likely	476	28.9 (25.6–32.2)
More likely	168	11.8 (9.6–14.0)
Total	1,640	100 (100.0–100.0)

†, how likely respondents think they are to develop lung cancer in the future; ‡, how likely respondents think they are to get lung cancer compared to the average person their age.

but not for relative risk perception (β=0.08; SE =0.06; 95% CI, –0.04–0.19) in multivariate models (*Table 4*).

Discussion

This study examined the association between lung cancer subjective (both absolute and relative) risk perceptions and cigarette-smoking behaviors among a large and nationally representative sample of U.S. adults, including both smokers and non-smokers. As an initial step, this study contributes to the cancer prevention and control field by clarifying how individuals interpret the relation between perceived lung cancer risk and their cigarette-smoking behaviors. In addition, it demonstrates how to appropriately identify and examine a risk perception-risk behavior hypothesis for cross-sectional survey data. Specifically, our results reveal the presence of a positive correlation between both absolute and relative risk perceptions and various cigarette-smoking behaviors. Because this is a correlation analysis, we could only test the accuracy hypothesis. Our findings support the accuracy hypothesis—people who smoke are generally aware that they have an increased risk of getting lung cancer. It is important to keep in mind that these data cannot be extrapolated to suggest causal relationships—either that higher lung cancer risk perception would lead to more smoking activities, or that engaging in smoking behavior leads to higher risk perception of getting lung cancer.

The findings reported here are consistent with those from prior research showing positive associations between absolute risk perception of acquiring lung cancer and smoking behaviors. For instance, Weinstein *et al*. (12) found a positive correlation between absolute risk perception and number of cigarettes smoked per day in a sample of 1,245 smokers. Dillard and Klein (13) used the same dataset, limiting their sample to current smokers with valid objective and subjective lung cancer risk data (n=377), and also observed that absolute risk perception was positively related to the number of cigarettes smoked per day. Our study extends previous work by examining more than one type of subjective risk perceptions and multiple cigarette-smoking behaviors (i.e., having smoked at least 100 cigarettes in entire lifetime, the frequency of smoking, and the number of cigarettes smoked). In addition, our sample consisted of a nationally representative sample of U.S. adults, including both smokers and non-smokers.

In this study, we found that individuals currently engaging in cigarette-smoking behaviors at the time perceived their risk of developing lung cancer as being increased. This finding suggests that lay people may generally be aware of the lung cancer health hazard message of cigarette smoking disseminated through widespread anti-smoking efforts by the U.S. government, mass media, and other non-profit organizations. Thus, health promotion strategies other than those focused on risk perception for lung cancer (e.g., programs to educate the risk of other types of cancers and diseases related to smoking, nicotine replacement therapy, behavioral treatments, and other medical aids) may be needed to increase the success of smoking prevention and control programs.

Furthermore, our findings suggest some differences between absolute and relative risk perceptions related to smoking behaviors. While both absolute and relative risk perceptions were associated with smoking at least 100 cigarettes during respondents' lifetimes and the frequency of their cigarette smoking, only absolute risk perception was related to the number of cigarettes that current smokers smoked per day. These findings suggest that absolute risk perception, rather than relative risk perception, might be a more sensitive index with which to measure perceived lung cancer risk. A potential explanation for these findings is that although both absolute and relative risk perceptions are types of subjective risk perceptions, these constructs are somewhat different. Past research, for instance, has indicated that absolute and relative risk perceptions explain different types of cancer worries and healthy behaviors (3,28). A

Table 3 Logistic regression models of absolute and relative risk perception on whether participants have smoked at least 100 cigarettes in their entire lives and, among ever smokers, how often they smoked cigarettes

Risk perceptions	Have smoked at least 100 cigarettes in the entire life[†] (yes *vs.* no[§]) OR (95% CI)	Frequency of cigarettes smoked[‡] (every day *vs.* not at all[§]) OR (95% CI)	Frequency of cigarettes smoked[‡] (some days *vs.* not at all[§]) OR (95% CI)
Absolute risk perception	2.82 (2.39–3.35)***	3.94 (2.74–5.66)***	2.27 (1.63–3.15)***
Gender: male *vs.* female	2.45 (1.65–3.61)***	–	–
Age	1.01 (1.00–1.03)***	0.95 (0.93–0.98)***	0.95 (0.92–0.99)**
Marital status: married/living with a partner *vs.* never been married	–	0.22 (0.09–0.53)**	–
Education: ≤ high school *vs.* ≥ college	–	2.25 (1.09–4.64)*	–
Read health newspaper/magazine: no *vs.* ≥1 week	–	3.11 (1.54–6.27)**	–
Relative risk perception	4.40 (3.38–5.73)***	3.65 (2.47–5.40)***	2.04 (1.38–3.02)***
Gender: male *vs.* female	2.04 (1.36–3.08)**	–	–
Age	1.02 (1.00–1.03)**	–	–
Marital status: married/living with a partner *vs.* never been married	2.21 (1.09–4.47)*	–	–
Education: ≤ high school *vs.* ≥ college	–	2.54 (1.43–4.52)**	–
Health care coverage: yes *vs.* no	–	0.27 (0.13–0.56)***	–

[†], binary logistic regression model; [‡], multinomial logic regression model; [§], reference group; *, P<0.05; **, P<0.01; ***, P<0.001.

Table 4 Multiple regression models of absolute and relative risk perceptions on the number of cigarettes participants smoked per day among current smokers

Risk perceptions	Number of cigarettes smoked per day	
	B (SE)	95% CI
Absolute risk perception	0.21 (0.06)**	0.09–0.34
Race/ethnicity: white *vs.* others	0.23 (0.09)*	0.04–0.42
Relative risk perception	0.08 (0.06)	–0.04–0.19
Race/ethnicity: white *vs.* others	0.27 (0.08)**	0.11–0.42
Race/ethnicity: black *vs.* others	0.10 (0.05)*	0.001–0.19
Gender: male *vs.* female	0.13 (0.06)*	0.01–0.25
Marital status: married/living with a partner *vs.* never been married	0.20 (0.09)*	0.02–0.38
Marital status: divorced/separated/widowed *vs.* never been married	0.20 (0.08)*	0.04–0.35

*, P<0.05; **, P<0.01.

previous study also found that relative risk perception was not correlated with the number of cigarettes an individual smoked per day (12). Future studies are needed to explore why absolute risk perception might better capture associations with smoking behaviors and via which mechanism.

Given that this study was a secondary data analysis; our results are limited by the measurement of subjective risk perception in the HINTS 2005 dataset. Only one-third

of the sample was randomly selected to answer questions related to subjective risk perceptions of getting lung cancer. Moreover, HINTS 2005 asked people to rate their lung cancer risk based on verbal scales (e.g., very low, somewhat low, moderate, somewhat high, and very high for absolute risk perception), which may yield different results than numerical scales (28,29). Additionally, the assessment of absolute risk perception was based on a 5-point scale, while a 3-point scale was utilized to assess relative risk perception. Although this difference might have affected the findings of this study, we found a similar pattern between these two different types of risk perceptions. The other limitation of this study is that we used the HINTS dataset from 2005. While using the latest HINTS dataset is desirable, the latest versions do not include questions regarding subjective risk perceptions of getting lung cancer. Given that the purpose of this study is to test an accuracy hypothesis, HINTS 2005 provides a national, representative sample with which we were able to examine our hypothesis.

Conclusions

In conclusion, our findings contributed to translational cancer research from a methodological perspective. When reading and interpreting scientific literature regarding risk perception and cigarette-smoking behaviors, researchers need to keep in mind (I) which hypotheses (i.e., the behavior motivation hypothesis, the risk reappraisals hypothesis, and the accuracy hypothesis) the studies examined, (II) which study designs (i.e., cross-sectional and longitudinal designs) the studies used, and (III) whether or not the hypothesis matched the research design. Based on the findings of this study, we propose a number of future research directions and recommendations. First, although our data support the accuracy hypothesis, longitudinal research with long-term data is needed to investigate other risk perception-risk behavior hypotheses, such as behavior motivation and risk reappraisals, among nationally representative samples to further examine the direction of causation for the association between risk perception and smoking behavior. Second, a systematic review or meta-analysis is particularly needed to provide an evidence-based understanding of the relationship between risk perception and cigarette smoking. Such systematic review or meta-analysis can help develop evidence-based cancer prevention and intervention programs. Third, in our study, we only focused on cigarette-smoking behaviors. Future research could examine risk perception and the use of different types of cigarettes people smoke (e.g., light and "natural" cigarettes, snus, snuff, dissolvables, cigars, and little cigars). Lastly, we examined risk perception for lung cancer because smoking is commonly linked to lung cancer; however, it may be useful to evaluate individuals' risk perception regarding other types of cancers and diseases.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was approved by the research team's institutional review boards (No. 07-135).

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