



Review

Measuring Cigarette Smoking Risk Perceptions

Annette R. Kaufman PhD, MPH,¹ Jenny E. Twesten MPH,²
Jerry Suls PhD,¹ Kevin D. McCaul PhD,³ Jamie S. Ostroff PhD,⁴ Rebecca A.
Ferrer PhD,¹ Noel T. Brewer PhD,^{5,6} Linda D. Cameron PhD,⁷
Bonnie Halpern-Felsher PhD,⁸ Jennifer L. Hay PhD,⁴ Elyse R. Park PhD,
MPH,^{9,10} Ellen Peters PhD,¹¹ David R. Strong PhD,^{12,13}
Erika A. Waters PhD, MPH,¹⁴ Neil D. Weinstein PhD,¹⁵
Paul D. Windschitl PhD,¹⁶ William M. P. Klein PhD¹

¹Behavioral Research Program, Division of Cancer Control and Population Sciences, National Cancer Institute, Rockville, MD; ²The Bizzell Group, LLC, Lanham, MD; ³Department of Psychology, North Dakota State University, Fargo, ND; ⁴Department of Psychiatry and Behavioral Sciences, Memorial Sloan Kettering Cancer Center, New York, NY; ⁵Department of Health Behavior, Gillings School of Global Public Health, University of North Carolina, Chapel Hill, NC; ⁶Lineberger Comprehensive Cancer Center, University of North Carolina, Chapel Hill, NC; ⁷School of Social Sciences, Humanities, and the Arts, University of California, Merced, Merced, CA; ⁸Division of Adolescent Medicine, Department of Pediatrics, Stanford University, Palo Alto, CA; ⁹Department of Psychiatry and Medicine, Massachusetts General Hospital, Boston, MA; ¹⁰Harvard Medical School, Boston, MA; ¹¹School of Journalism and Communication, University of Oregon, Eugene, OR; ¹²Department of Family Medicine and Public Health, University of California, San Diego, San Diego, CA; ¹³Cancer Prevention and Control Program, Moores Cancer Center, University of California, San Diego, San Diego, CA; ¹⁴Division of Public Health Sciences, Department of Surgery, Washington University School of Medicine in St. Louis, Saint Louis, MO; ¹⁵Department of Human Ecology, School of Environmental and Biological Sciences, Rutgers, The State University of New Jersey, New Brunswick, NJ; ¹⁶Department of Psychological and Brain Sciences, College of Liberal Arts and Sciences, University of Iowa, Iowa City, IA

Corresponding Author: Annette R. Kaufman, PhD, MPH, 9609 Medical Center Drive, Rockville, MD 20850, USA. Telephone: 240-276-6706; Fax: 240-276-7907; E-mail: kaufmana@mail.nih.gov

Abstract

Risk perception is an important construct in many health behavior theories. Smoking risk perceptions are thoughts and feelings about the harms associated with cigarette smoking. Wide variation in the terminology, definition, and assessment of this construct makes it difficult to draw conclusions about the associations of risk perceptions with smoking behaviors. To understand optimal methods of assessing adults' cigarette smoking risk perceptions (among both smokers and nonsmokers), we reviewed best practices from the tobacco control literature, and where gaps were identified, we looked more broadly to the research on risk perceptions in other health domains. Based on this review, we suggest assessments of risk perceptions (1) about multiple smoking-related health harms, (2) about harms over a specific timeframe, and (3) for the person affected by the harm. For the measurement of perceived likelihood in particular (ie, the perceived chance of harm from smoking based largely on deliberative thought), we suggest including (4) unconditional and conditional items (stipulating smoking behavior) and (5) absolute and comparative items and including (6) comparisons to specific populations through (7) direct and indirect assessments. We also suggest including (8) experiential (ostensibly automatic, somatic perceptions of vulnerability to a harm) and affective (emotional reactions to a potential harm) risk perception items. We also

offer suggestions for (9) response options and (10) the assessment of risk perception at multiple time points. Researchers can use this resource to inform the selection, use, and future development of smoking risk perception measures.

Implications: Incorporating the measurement suggestions for cigarette smoking risk perceptions that are presented will help researchers select items most appropriate for their research questions and will contribute to greater consistency in the assessment of smoking risk perceptions among adults.

Introduction

There are about 1.1 billion smokers worldwide (21% of the world's population) aged 15 years and older.¹ However, causal evidence of the harms of smoking and decades of research and work to define and implement effective tobacco control programs and policies have contributed to the reduction of cigarette smoking.² Smoking prevalence in very high Human Development Index (HDI) countries,³ after declining for several years, has plateaued. Meanwhile smoking in many medium- or high-HDI countries continues to rise or remain high, and in some low-HDI countries, smoking has increased.⁴ The public's inaccurate perceptions of smoking risk⁵ may be one contributing factor and have motivated public health proponents to increase their understanding of how people view the harms of cigarettes. We define *smoking risk perceptions* as thoughts and feelings about the harm associated with cigarette smoking. Risk perceptions are central to numerous health behavior theories, and attempts to heighten risk perceptions are important in tobacco control efforts targeting prevention and cessation.⁶

Despite the appeal of risk perceptions as predictors of smoking-related behaviors, variations in terminology, operational definition, and measurement make it difficult to draw conclusions about the association of risk perceptions with such behaviors. For example, one study found that smokers in the United States (US) overestimate their risk for lung cancer⁷ (which is a finding that might result from people's difficulties using numerical response options⁸). However, other research has shown that smokers in the US underestimate their own risk of lung cancer relative to others.^{5,9} These inconsistencies may stem from the variations in how risk perceptions are measured, as Weinstein¹⁰ observed over two decades ago. A recent review of tobacco control research found considerable heterogeneity among risk perception assessment methods, including variation in how respondents are queried about different harms (eg, general vs. specific disease risk), timeframes (eg, next 10 years vs. lifetime), risk targets (eg, self or other people), and different formats and response scales.⁶ Furthermore, some researchers may adopt risk perception measures with a less-than-optimal consideration of whether features of the measures (eg, question specificity) match study goals, hypotheses, and populations (e.g., local, regional, or global). For example, researchers may select risk perception items from a national or global survey that may be too general for the purpose of a more specific study. It is scarcely surprising that prior studies have not provided definitive conclusions about associations between smoking risk perceptions and behaviors.¹¹⁻¹³ Both selecting the appropriate assessments and interpreting disparate outcomes, based on different measures, are ongoing challenges in tobacco control.

This paper aims to provide guidance on measuring smoking risk perceptions for adult smokers and nonsmokers, as most of the literature on cigarette risk perceptions focuses on adults.⁶ Research has shown that adolescents and adults may differ in their risk perceptions, with the former viewing risky behaviors as significantly

less harmful.¹⁴ With the emergence of other tobacco and nicotine-containing products and changes in use patterns among youth (eg, the dramatic rise in e-cigarette use in the US¹⁵), the assessment of risk perceptions among adolescents may necessitate different considerations. For example, US data show that when assessing perceptions of harm associated with use of tobacco products other than cigarettes, comparisons of harm across products can be useful.¹⁶ Also, when conducting studies with adolescents, using vignettes to assess risk perception may be more engaging than conventional survey questions.¹⁷

This article presents researchers with guidance to inform the selection, use, and future development of measures of cigarette smoking risk perceptions for adults. We present an overview of risk perception measurement characteristics with an emphasis on the importance of specificity in measurement. A description follows of assessment tools for different aspects of perceived likelihood and for *affective* and *experiential* risk perceptions in particular. Finally, we address several methodological issues such as the selection of response scales, the importance of longitudinal studies, and the future directions for smoking risk perception research. Where empirical evidence from smoking research is mixed or unavailable, research in other health domains is consulted, expert opinions are offered, or new questions for researchers are suggested. Table 1 summarizes key smoking risk perception measurement characteristics: harm, timeframe of harm, target of harm, use of conditional versus unconditional on smoking behavior risk estimates, and dimension (ie, perceived likelihood, experiential risk perception, and affective risk perception). In the interests of clarity and brevity, we do not discuss several other risk-related constructs, such as perceived severity, knowledge,¹⁸ anticipated regret,¹⁹ and cognitive biases.²⁰

Specificity in Measuring Cigarette Smoking Risk Perception

A useful place to begin is with Brewer et al.'s²¹ recommendations for measuring perceptions related to the likelihood of harm. Adapting these recommendations to the smoking domain, a questionnaire item should: (1) focus on specific harms rather than general ones (eg, lung cancer rather than "disease"), (2) identify a timeframe for the harm (eg, in your lifetime rather than no timeframe specified), (3) specify the person or target for whom the risk is being evaluated (eg, self, a smoker your age and sex), and (4) make the risk perception contingent on smoking behavior or exposure (eg, "If you continue smoking the same number of cigarettes every day, how likely do you think it is that you will...," "If you stay quit, how likely do you think you will...," or "If you never start smoking, how likely do you think you will..."). In a meta-analysis of vaccination research, Brewer et al.²² found that studies using more specific measures reported stronger associations between risk perceptions and health behavior than studies using less specific measures. Specificity standards were also proposed

Table 1. Characteristics of Smoking Risk Perception Items

Characteristic	Description	Levels of characteristic	Example item (relevant text italicized when needed)
Harm	Health or other problem caused by behavior	General: Generic problem Broad: Problem category Specific: Specific problems	How likely do you think it is that you will experience <i>harm</i> ? ¹ How likely do you think it is that you will get <i>cancer</i> ? ¹ How likely do you think it is that you will get <i>lung cancer</i> ? ¹
Timeframe of harm	The length of time until one might experience the harm	Unit: Time in days, weeks, months, years, or a lifetime Unspecified: Does not specify the timeframe	How likely do you think it is that you will get lung cancer <i>in your lifetime</i> ? ¹ How likely do you think it is that you will get lung cancer? ¹
Target of harm	Person who experiences the harm	Self: Respondent answers about the harm to himself or herself Other: Respondent answers about the harm to other people Comparison: One person compared to another	How likely do you think it is that <i>you</i> will get lung cancer? ¹ How likely do you think it is that an <i>average person</i> your age, race, and sex will get lung cancer? ¹ <i>Compared to an average person your age, race, and sex</i> , how likely do you think it is that you will get lung cancer in your lifetime? ²
Conditional on smoking behavior	Statement of whether respondent engages in a risk or protective behavior	Conditional: Makes the risk assessment contingent on a risk behavior or protective behavior Unconditional: Does not specify a risk or protective behavior	<i>If you continue smoking the same number of cigarettes every day</i> , how likely do you think it is that you will get lung cancer? ¹ How likely do you think it is that you will get lung cancer? ¹
Dimension	Aspect of risk perception measured	Perceived likelihood: Perceived probability of experiencing a harm, based on deliberative thought Experiential risk perception: Perceived vulnerability to a harm, based on a quick response made without much deliberative thought Affective risk perception: Emotional response to a potential harm	How <i>likely</i> do you think it is that you will get lung cancer? ¹ I feel <i>vulnerable</i> to getting lung cancer. ³ How <i>worried</i> are you about getting lung cancer? ⁴

Conventional response options¹Not at all likely, A little likely, Somewhat likely, Very likely, Extremely likely, Don't know.²Much less likely, Less likely, About as likely, More likely, Much more likely, Don't know.³Strongly disagree, Somewhat disagree, Neither disagree nor agree, Somewhat agree, Strongly agree.⁴Not at all, Slightly, Moderately, Very, Extremely.

by The National Academies of Sciences, Engineering, and Medicine²³ for studies of modified risk tobacco products. Complementing this guidance, the following sections offer 10 suggestions for measuring adults' perceived cigarette smoking risk. These suggestions are developed based on research examining perceived likelihood, which refers to the perceived probability of experiencing a harm from smoking. These perceptions are generally based on deliberative—that is, cognitive or conscious—thought. Two other types of risk perceptions discussed later in the paper are *experiential risk perceptions* and *affective risk perceptions*. Many of the suggestions are relevant to these types of risk perceptions as well.

Harm

Specificity of the harm associated with smoking can vary from general (eg, harm), to broad (eg, cancer), to more specific (eg, lung cancer). If items refer to only general harm, study results may be difficult to interpret.²³ By including multiple items to assess risk perception for specific harms, researchers can identify the harms perceived to most influence smoking behavior. This premise is grounded in psychological theory positing that attitudinal items should specify the outcome(s) that are specific to the target behavior.²⁴ We suggest

using a set of perceived risk items that refer to different smoking-related health harms (suggestion 1).

Timeframe of Harm

Harms can occur in the short term, long term, or a combination of both. Thus, the selection of a harm timeframe in risk perception questions depends on the type of harm being assessed. The selection of the timeframe also depends partly on the goals of the study. The most severe harms of cigarette smoking (eg, lung cancer, emphysema) are cumulative and often take many years to appear. For example, evaluations of adult smoker-targeted campaigns—such as the Tips From Former Smokers²⁵ campaign in the US that focuses on personal stories about smoking's long-term harms—could examine long-term perceived risk. Other studies may focus on short-term consequences. For example, among patients diagnosed with cancer in the US, smokers report a significantly higher symptom burden (eg, fatigue, nausea, pain) than those who quit smoking before treatment²⁶ and thus may have different short-term perceived risks of smoking. Future research should examine short- and long-term harms and the most appropriate timeframes in risk perception questions. We suggest specifying a harm timeframe when assessing risk

perceptions (suggestion 2). The questions could specify a particular timeframe (eg, “How likely do you think it is that you will experience tooth decay in the next 10 years?”), or “in your lifetime” for a long-term outcome, such as lung cancer. If several timeframes are relevant, one can consider using multiple questions.

Target of Harm

A global assessment of harm for other people, all smokers, or an ambiguous group (eg, “Cigarette smoking represents a major risk to health”) is less likely to yield meaningful associations with respondents’ behavior than an assessment of their personal risk (eg, “Cigarette smoking represents a major risk to *my* health”).²² We suggest using the person who will potentially be affected by the behavior (usually the survey respondent) as the target of risk perception items (suggestion 3). Respondents can also be asked to rate their risk relative to that of others, such as smokers, former smokers, or nonsmokers; this is a comparative measure of perceived risk, which is discussed later.

Conditional or Unconditional on Smoking Behavior

Some researchers query about the risk of harm without specifying what behavior the risk is contingent upon (eg, “How likely do you think it is that you will get lung cancer?”).²² Respondents might answer these unconditional risk questions based on factors salient at the time but unknown to the researchers (eg, having a close relative with a smoking-related disease). Importantly, such an item does not assess whether the respondent expects to change their smoking behavior (eg, start or continue smoking, cut down, or stop smoking) sometime in the future. This mix of possible future intentions will likely increase error and thereby could obscure the association between perceived risk and smoking behavior.

Conditional items, in contrast, stipulate the smoking behavior upon which the perceived risk of harm is contingent, such as the number of cigarettes regularly smoked.²⁷ Several researchers, in both international and US studies, have suggested that conditional items may improve the prediction of smoking behavior.^{12,27–29} Although no studies have examined the superiority of conditional items over unconditional items in predicting smoking behavior, there is empirical evidence for other health behaviors (eg, dental flossing in the US,²⁹ AIDS-related risk behavior in the Netherlands³⁰) showing that conditional risk perception items are stronger predictors of behavior. Conditional items could use stems, such as “If you continue smoking the same number of cigarettes every day...” (current smokers), “Considering how long and frequently you used to smoke, if you stay quit...” (former smokers), or, “If you never start smoking...” (never smokers). The National Academies of Sciences, Engineering, and Medicine report on modified risk tobacco products speculated that the conditional behavior might be better communicated in more detailed hypothetical risk scenarios to improve predictions about behavior²³ (eg, “Imagine that you just **BEGAN SMOKING**. You smoke about 2 OR 3 CIGARETTES EACH DAY. Sometimes you smoke alone, and sometimes you smoke with friends. If you smoke about 2 or 3 cigarettes each day, what is the chance that ... you will get a bad cough from smoking?”³¹). This possibility requires more study.

If researchers use unconditional items, they may want to supplement them with cognitive interviewing to ascertain what conditions respondents call to mind when answering the questions. At this time, the field needs more evidence to determine the advantage of conditional items over unconditional items in the domain of adult

cigarette smoking risk perceptions. We suggest using both unconditional and conditional perceived risk items to identify differences in perceived risk of smoking (suggestion 4). If practical considerations (eg, respondent burden, expense) permit only a single risk perception item, we suggest conditioning the item on the respondent’s current smoking behavior, as health behavior models suggest perceived risk associated with current behavior is more likely to motivate behavior change.³² These first four suggestions are designed to avoid vague questions and to maximize the chances that respondents will answer questions about their thoughts of harm related to cigarette smoking and will avoid ambiguity that may obscure the intended meaning of the question.

Absolute, Direct Comparative, and Indirect Comparative Measures

Absolute Versus Comparative Measures of Risk Perception

The earliest smoking risk perception measures inquired about the perceived likelihood of harm in *absolute*, or personal, terms (eg, “How likely do you think it is that you will get lung cancer?”).¹⁸ The original purpose was to determine whether people over- or underestimated the disease risks of smoking, typically by comparing the estimates to population data.¹⁸ In contrast to absolute risk, *comparative*, or relative, risk items query about the perceived likelihood of risk relative to other people (eg, for nonsmokers, “Compared to smokers, how likely do you think it is that you will get lung cancer in your lifetime?” or for smokers “Compared to other smokers, how likely do you think it is that you will get lung cancer in your lifetime?”). Absolute and comparative likelihood measures are often highly correlated (eg, people who see their absolute risk as high also tend to see their comparative risk as high),³³ and on occasion, absolute and comparative risk perceptions have been combined into a single index for analysis.³⁴

The associations of absolute and comparative perceived likelihood with smoking behavior vary, likely due to heterogeneity in measurement across studies.^{35,36} In a US study, Kaufman et al.³⁷ found that absolute and comparative risk perception items loaded onto two distinct factors for smokers, but for former smokers the items loaded onto a single factor. The authors speculated that smokers are *motivated* to differentiate these two concepts—acknowledging their risk on absolute scales but defending themselves from this threat by reporting their comparative risk as less than that of others.

In designing items to assess comparative risk, researchers should select a comparison group that is meaningful to the respondents and consistent with the study goal.³⁸ For example, if the intention is to influence behavioral intentions to quit smoking, it is best to use items soliciting a comparison to an aggregate “average” referent group (eg, “the average US student your age and sex”), which in one study were shown to be more predictive of behavioral intentions than items soliciting comparisons with a single referent (eg, “best friend”).³⁹ In the empirical literature examining smoking in the US, comparative risk items ask current and former smokers to compare their likelihood of harm to that of “other former/current smokers” (eg, Park et al.³⁴) and “others/same race, age, and sex” (eg, Lyna et al.⁴⁰). Finally, disparities in smoking and smoking-related outcomes exist, for example, by race, ethnicity, education level, socioeconomic status, and different regions in the US,⁴¹ which makes the specificity in comparative risk perception assessment particularly important.

In summary, existing research on the associations between respondents' perceptions of their absolute risk likelihood versus their perceptions of comparative risk likelihood with health behaviors yields varying conclusions.^{10,35,36} Because most evidence comes from other health domains, this topic is a promising one for future research examining the perceived likelihood of smoking harms. To fill this gap, we suggest researchers query both absolute and comparative perceived likelihoods of the harms of smoking and analyze the measures separately (suggestion 5). Furthermore, we suggest using specific referent groups (eg, never/former/current smokers your age, race, and sex) for comparative perceived likelihood questions (suggestion 6).

Direct and Indirect Comparative Measures of Perceived Likelihood

Comparative perceived likelihood measures take two forms. In the *direct method*, a single survey item assesses the perceptions of perceived likelihood of harm relative to a referent (eg, "Compared to an average person your age, race, and sex, how likely do you think it is that you will get lung cancer in your lifetime?"). In the *indirect method*, separate survey items assess the perceived likelihood for the respondent (eg, "How likely do you think it is that you will get lung cancer in your lifetime?") and a referent (eg, "How likely do you think it is that an average person your age, race, and sex will get lung cancer in their lifetime?"). Then, one estimate is subtracted from the other to establish whether a respondent's perceived likelihood of harm is higher, lower, or the same as their perception of the referent's likelihood.^{42,43} The direct and indirect comparative methods have yielded divergent findings. In research studies from various countries, respondents exhibit pessimistic perceptions of harm likelihood in direct comparisons but are optimistic in indirect comparisons.⁴⁴ The exact reasons for these different patterns remain under investigation.^{42,45}

Of potentially more importance, Krosnick et al.⁹ found that comparative indices of likelihood for harm were more strongly associated with cessation than were absolute judgments in a US sample of smokers and former smokers. A similar pattern was shown when testing the associations of direct versus indirect comparisons with behaviors and behavioral intentions in other health domains.⁴⁶ This pattern is consistent with the idea that peoples' health concerns and behavioral intentions are shaped by their perceptions of social comparative standing.³⁹ Thus, measures that are more explicitly "comparative" (ie, direct measures) may better predict behavior because they tap into two important motivators—the perception of one's own risk and standing relative to others⁴⁶ (also see Ranby et al.⁴⁷ about psychometric problems associated with difference scores derived from absolute scales). More research, however, is needed to ascertain whether the direct method of assessing comparative likelihood is more reliably associated with smoking behavior relative to the indirect method. We suggest including both direct and indirect comparative perceived likelihood items (suggestion 7).

Experiential and Affective Risk Perceptions

Numerous health behavior theories focus on cognitions or deliberative thought.³² Indeed, a review of early studies of risk perceptions, including smoking-related risk perceptions, emphasized *thinking* about the perceived likelihood of experiencing harm.³² However, risk perceptions also include how people *feel* about potential harms, which are distinctly different from perceived likelihood.^{48,49} Two

important types of feelings about the risk of harm are *experiential risk perceptions* (ie, ostensibly automatic, somatic perceptions of vulnerability to a harm that represent "gut-level" feelings) and *affective risk perceptions* (ie, emotional reactions to a harm, such as fear or worry).^{50,51} Experiential risk perceptions are gut reactions to harms and could be measured with such statements as: "My first reaction when I hear of someone getting lung cancer is 'that could be me someday'" and "I feel vulnerable to getting lung cancer."⁵¹ Affective risk perceptions are emotional responses people experience when thinking about the harm or potential for harm, and could be measured with such items as: "How worried are you about getting lung cancer in your lifetime?" or "When you think about lung cancer, to what extent do you feel fearful?"⁵¹

Although often conflated in practice, experiential and affective risk perceptions are *conceptually* and *empirically* distinct. Conceptually, one's intuition about experiencing an event is not equivalent to positive or negative feelings about experiencing the event.⁵⁰ For example, people can intuitively feel they are not personally vulnerable to lung cancer (even knowing deliberately that their risk for lung cancer is comparatively high), but can still feel scared when thinking about lung cancer. Accordingly, experiential and affective risk perceptions are empirically distinct based on factor-analytic findings⁵² and research showing distinct associations with various health behaviors.^{51,53} Indeed, two US studies have shown that experiential risk perceptions are more aligned with deliberative risk perceptions, such as perceived likelihood, than with affective risk perceptions.^{51,52} Thinking that something is likely to happen at a gut-level can occur without necessarily experiencing emotions like worry and anxiety.⁵⁴

These three dimensions of risk perception (perceived likelihood, experiential risk perception, and affective risk perception) each predict unique variance in health-related intentions and preventive behavior, including smoking.^{52,55} Tobacco control studies have been more likely to include affective^{56,57} than experiential⁵⁵ risk perception items. For example, one longitudinal study in the US found that both the perceived likelihood of developing a medical condition and affective risk perceptions (labeled "worry") mediated the effects of a brief smoking cessation intervention on considering quitting.⁵⁶ Cross-sectional studies have assessed experiential risk perception in addition to perceived likelihood and affective risk perception. Some studies have found that all three were differentially associated with smoking intentions, and others found similar—but independent—associations with smoking intentions. For example, a cross-sectional examination of adult smokers in the Netherlands found that intentions to quit smoking were independently associated with both affective and experiential risk perceptions but not with perceived likelihood.⁵⁵ Other cross-sectional and longitudinal evidence for tobacco and other cancer risk domains from the US and the Netherlands suggests that affective and experiential risk perceptions may be as or more important than perceived likelihood for predicting behavior change.^{53,58} Conceptualizations of risk perception as affective and experiential are only beginning to be incorporated into smoking research, particularly in longitudinal and experimental studies. We suggest assessing affective and experiential risk perceptions (suggestion 8).

Response Scales for Risk Perception Items

Researchers have used two main response scale formats in smoking risk perception items, particularly those measuring perceived

likelihood: (1) numerical estimates (eg, 0% to 100% chance) and (2) qualitative verbal descriptors (eg, “not at all likely” to “extremely likely”). Numerical response scales may pose unique problems; individuals often have difficulty interpreting numbers, particularly percentages and odds, when assessing risk.^{8,59-61} Also, when presented with a numerical response scale, a substantial proportion of participants in a US sample selected 50% or “50 out of 100.”⁶² On the other hand, verbal descriptors, such as “very likely,” are subjective and do not have reliable numerical equivalents, a problem that is exacerbated among people in the US with low health literacy.⁶³ Given individuals’ widespread challenges with numerically estimating risk, however, we suggest that all risk perception items use response scales with all points labeled with verbal categories (suggestion 9).

Another consideration is the inclusion of a “don’t know” response option for perceived likelihood items. US nationally representative samples have shown that between 7% and 9% of participants provide a “don’t know” response.⁶⁴ Individuals who use the “don’t know” response option generally have demographic characteristics associated with health disparities (eg, racial minorities), including lower health knowledge and reduced knowledge acquisition behaviors and skills.^{64,65} Including a “don’t know” response option may decrease the number of people using the explicitly provided response scale, but it can identify an important segment of the population that may need a more intensive or different intervention strategy.⁶⁴⁻⁶⁶ Future research should examine whether adding a “don’t know” response option improves the behavioral prediction

of perceived likelihood items. We suggest that researchers consider the benefits and drawbacks of including a “don’t know” response option when assessing perceived likelihood. If included, sensitivity analyses should be conducted to determine whether their findings differ among people who do and do not respond “don’t know.” It is also unclear whether people are less likely to answer “don’t know” for affective and experiential risk perception items, as this option has not often been included with such measures.

Longitudinal Assessment of Risk Perceptions

Studies assessing risk perceptions over time demonstrate consistent responses, suggesting that these measures are reliable.^{37,67} One of the few longitudinal tobacco studies to examine smoking-related risk perceptions and smoking behavior over time among adults found that US patients diagnosed with a tobacco-related cancer who quit smoking reported feeling at *lower risk* for developing cancer recurrence compared to those who continued smoking.⁶⁸ This finding is consistent with a risk reappraisal pattern.²¹ Furthermore, those who quit smoking but subsequently relapsed (vs. continuing smokers or those who quit successfully) were *most* likely to view themselves at greater risk for cancer recurrence.⁶⁸

One of the challenges for researchers is choosing the frequency and timing for risk perception measurement. For example, assessing risk perception in the context of lung cancer screening before and after the disclosure of screening findings can reveal if and how risk

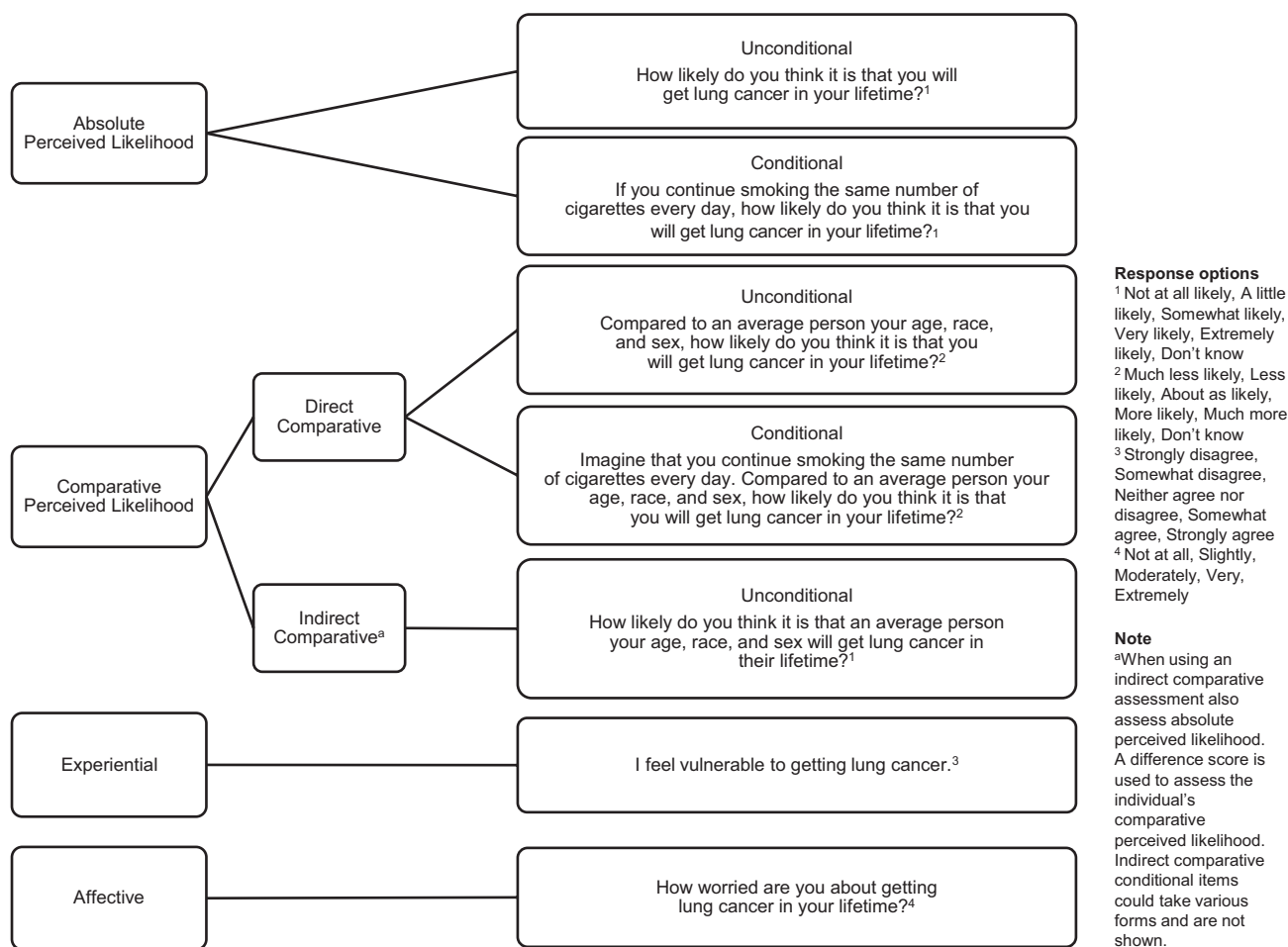


Figure 1. Example survey items for assessing adult cigarette smokers' risk perceptions of lung cancer.

perceptions are altered by learning the findings and whether they motivate later smoking cessation.^{34,69} More research is needed to determine whether temporal variation in risk perceptions should be captured using more frequent assessments, such as ecological momentary assessment, to ascertain when risk estimates best predict behavior (ie, days, weeks, months). We suggest that researchers consider assessing risk perceptions at multiple time points to track changes (suggestion 10), for example, before and after the delivery of tobacco treatment interventions including a risk communication component.⁷⁰ However, researchers should always consider whether assessing risk perceptions directly before an intervention may affect people's response to the intervention and/or risk perception responses after the intervention (eg, because of priming, demand characteristics, or reactivity).

Final Considerations

Example items and response options for assessing smoking risk perceptions of adult smokers appear in Figure 1. This item tree applies the suggestions provided in this article to illustrate what the items might look like for each risk perception dimension using lung cancer as a potential harm. A researcher might choose to use one or a subset of these perceived risk items; however, administering a variety of items may provide a better assessment because risk perception is multidimensional.⁷¹ Well-designed multi-item measures, rather than single items, increase reliability, increase internal consistency, reduce error, and yield better predictive validity.⁷² Including a variety of risk perception items can also support theory-building and inspire new interventions to reduce smoking.

To advance the field of risk perception measurement, more knowledge about how people interpret instructions, items, and response scales is needed. With cognitive interviewing, researchers may uncover more about the intuitive processing of tobacco risks.⁷³ Wherever risk perception items are placed within the context of a larger survey, the sequence of the items may be important because they may influence and be influenced by other survey items (see Bradburn et al.⁷⁴ and Dillman⁷⁵ for general survey recommendations). For example, when including multiple different assessments of risk perception within a questionnaire, it is prudent

to clearly highlight what makes the item different from others by underlining or bolding text and using wording that emphasizes the differences at the beginning of the items (eg, "Compared to smokers...").

Although we have primarily considered cigarette smoking risk perceptions for adults, including both smokers and nonsmokers, our measurement suggestions may also be relevant to other risk behaviors, other tobacco products, and assessments of risk perceptions in youth. The introduction of new combustible and noncombustible tobacco products has made the need for a systematic and comprehensive assessment of the public's perceived risk of tobacco product use more serious. Studies, mainly with US samples, are emerging about direct and indirect comparative harm perceptions of various tobacco products.^{76–79} However, little work has explored how the comparison group, conditions, affect, experiential risk perceptions, etc., may apply more broadly to tobacco product harm perceptions and the ability of risk perception measures to predict tobacco use. Future work may also shed light on how smoking risk perception measures can be used to help evaluate tobacco control communication campaigns.

Summary and Future Directions

To most effectively assess adult cigarette smoking risk perceptions, we recommend following the suggestions summarized in Table 2, keeping in mind how a study's goals and hypotheses might inform the selection or development of various risk perception items. We also encourage developers of national and global surveys to take these suggestions into account.

Given the wide variability in current smoking risk perception items, future research needs are numerous. Some important topics for further exploration include understanding whether specific risk perceptions (eg, lung cancer) are more predictive of smoking behavior (eg, initiation, escalation, continuation, relapse, cessation) than general risk perception (eg, harm), which specific harms to select, and what the appropriate timeframes are for assessing risk perceptions of short- and long-term harms of smoking. More research is needed to understand the predictive validity of unconditional risk perception items, conditional risk perceptions, and risk scenarios in the context of smoking behavior change. Further work to resolve the divergent findings in the literature examining absolute and comparative perceived likelihoods of smoking harms for adults would be valuable. Relatedly, although some work has begun to examine the direct or indirect approaches for assessing comparative perceived likelihood, more research is needed to understand which may be most predictive of smoking behavior. Future research could examine the predictive validity of incorporating "don't know" response options for perceived likelihood items. Finally, other risk perception and related constructs (eg, perceived severity, knowledge, cognitive biases, or anticipated regret) may merit more attention in smoking risk perception studies. As more research is conducted to address these issues, we will better understand if a general smoking risk perception measure may serve the needs of various types of studies or if researchers should continue to develop ad hoc risk perception items for their studies.

Conclusions

Risk perceptions appear to be associated with smoking behaviors among adults, including initiation and quitting. Nevertheless, delineating the precise connections between smoking risk perceptions

Table 2. Suggestions for Assessing Smoking Risk Perceptions Among Adults

1. Assess risk perceptions about multiple smoking-related health harms.
2. Specify a timeframe for the harm.
3. Use the person who will potentially be affected by the behavior (usually the survey respondent) as the risk target.
4. Include perceived likelihood items conditioned and not conditioned on current smoking behavior. If only one risk perception item is included, condition the item on current smoking behavior.
5. Include both absolute and comparative perceived likelihood items.
6. Compare risk to a defined population in comparative perceived likelihood items.
7. Include both direct and indirect comparative perceived likelihood items.
8. Include both affective and experiential risk perception items.
9. Use response options where all points are labeled using verbal categories.
10. Assess risk perceptions at multiple time points to track changes in risk perception over time.

and smoking behavior requires improved measurement of the constructs discussed in this article. Although there are limitations of self-reported risk perception questionnaires for assessing individuals' thoughts and feelings, there is seldom an alternative to this measurement approach, and we should try to find the questions that will best inform tobacco control efforts. We have identified several measurement topics for researchers to consider and have highlighted the needs for further research. Attention to these issues will help us better understand how risk perceptions may influence cigarette smoking behaviors and, ultimately, facilitate the larger goal of reducing tobacco use and its health consequences.

Funding

This work was supported in part by the National Cancer Institute at the National Institutes of Health (contract number HHSN261201700004I).

Declaration of Interests

E.R.P. receives royalties from UpToDate on a chapter authored for physicians counseling smokers and Pfizer provided varenicline for a previous R01 trial.

Acknowledgments

The authors would like to thank Michele Bloch, Joseph Cappella, Geoffrey Fong, Erin O'Brien, Alexander Persoskie, and Gordon Willis for their comments and participation in a workshop that catalyzed the development of this article. The content of this publication is solely the responsibility of the authors and does not necessarily represent the official views or policies of the US National Cancer Institute, National Institutes of Health, or Department of Health and Human Services, nor does the mention of trade names, commercial products, or organizations imply endorsement by the US government.

References

- National Cancer Institute. *The Economics of Tobacco and Tobacco Control*. NCI Tobacco Control Monograph Series 21. NIH Publication No. 16-CA-8029A. Bethesda, MD: US Department of Health and Human Services, National Institutes of Health, National Cancer Institute/Geneva, Switzerland: World Health Organization; 2016.
- U.S. Department of Health and Human Services. *The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2014:17.
- United Nations Development Programme. *Human Development Index*. New York: United Nations Development Programme; 2018. <http://hdr.undp.org/en/content/human-development-index-hdi>. Accessed October 16, 2019
- Drope J, Schluger NW, Cahn Z, et al. Prevalence. In: Drope J, Schluger NW, eds. *The Tobacco Atlas*. 6th ed. Atlanta, GA: American Cancer Society and Vital Strategies; 2018:20–21.
- Weinstein ND, Marcus SE, Moser RP. Smokers' unrealistic optimism about their risk. *Tob Control*. 2005;14(1):55–59.
- Kaufman AR, Persoskie A, Twesten J, Bromberg J. A review of risk perception measurement in tobacco control research. *Tob Control*. 2018. doi:10.1136/tobaccocontrol-2017-054005.
- Viscusi WK. Do smokers underestimate risks? *J Polit Econ*. 1990;98(6):1253–1269.
- Windschitl PD. Judging the accuracy of a likelihood judgment: the case of smoking risk. *J Behav Decis Making*. 2002;15(1):19–35.
- Krosnick JA, Malhotra N, Mo CH, et al. Perceptions of health risks of cigarette smoking: a new measure reveals widespread misunderstanding. *PLoS One*. 2017;12(8):e0182063.
- Weinstein ND. Accuracy of smokers' risk perceptions. *Ann Behav Med*. 1998;20(2):135–140.
- Borrelli B, Hayes RB, Dunsiger S, Fava JL. Risk perception and smoking behavior in medically ill smokers: a prospective study. *Addiction*. 2010;105(6):1100–1108.
- Costello MJ, Logel C, Fong GT, Zanna MP, McDonald PW. Perceived risk and quitting behaviors: results from the ITC 4-country survey. *Am J Health Behav*. 2012;36(5):681–692.
- Norman P, Conner M, Bell R. The theory of planned behavior and smoking cessation. *Health Psychol*. 1999;18(1):89–94.
- Cohn LD, Macfarlane S, Yanez C, Imai WK. Risk-perception: differences between adolescents and adults. *Health Psychol*. 1995;14(3):217–222.
- U.S. Department of Health and Human Services. *E-Cigarette Use Among Youth and Young Adults. A Report of the Surgeon General*. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2016.
- Strong DR, Leas E, Elton-Marshall T, et al. Harm perceptions and tobacco use initiation among youth in Wave 1 and 2 of the Population Assessment of Tobacco and Health (PATH) Study. *Prev Med*. 2019;123:185–191.
- Song AV, Morrell HE, Cornell JL, et al. Perceptions of smoking-related risks and benefits as predictors of adolescent smoking initiation. *Am J Public Health*. 2009;99(3):487–492.
- Weinstein ND. What does it mean to understand a risk? Evaluating risk comprehension. *J Natl Cancer Inst Monogr*. 1999;25:15–20.
- Brewer NT, DeFrank JT, Gilkey MB. Anticipated regret and health behavior: a meta-analysis. *Health Psychol*. 2016;35(11):1264–1275.
- Slovic P, ed. *Smoking: Risk, Perception, & Policy*. Thousand Oaks, CA: Sage Publications; 2001.
- Brewer NT, Weinstein ND, Cuite CL, Herrington JE. Risk perceptions and their relation to risk behavior. *Ann Behav Med*. 2004;27(2):125–130.
- Brewer NT, Chapman GB, Gibbons FX, Gerrard M, McCaul KD, Weinstein ND. Meta-analysis of the relationship between risk perception and health behavior: the example of vaccination. *Health Psychol*. 2007;26(2):136–145.
- Institute of Medicine. *5 Methods for Studying Risk Perception and Risk Communication. Scientific Standards for Studies on Modified Risk Tobacco Products*. Washington, DC: The National Academies Press; 2012:191–220.
- Fishbein M, Ajzen I. *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research*. Reading, MA: Addison-Wesley; 1977.
- Centers for Disease Control and Prevention. Tips From Former Smokers. 2017. <https://www.cdc.gov/tobacco/campaign/tips/>. Accessed January 16, 2019
- Peppone LJ, Mustian KM, Morrow GR, et al. The effect of cigarette smoking on cancer treatment-related side effects. *Oncologist*. 2011;16(12):1784–1792.
- van der Pligt J. Perceived risk and vulnerability as predictors of precautionary behaviour. *Br J Health Psychol*. 1998;3(1):1–14.
- Halpern-Felsher BL, Millstein SG, Ellen JM, Adler NE, Tschanz JM, Biehl M. The role of behavioral experience in judging risks. *Health Psychol*. 2001;20(2):120–126.
- Ronis DL. Conditional health threats: health beliefs, decisions, and behaviors among adults. *Health Psychol*. 1992;11(2):127–134.
- van der Velde F, Hooikaas C, van der Pligt J. Conditional versus unconditional risk estimates in models of AIDS-related risk behaviour. *Psychol Health*. 1996;12(1):87–100.
- Morrell HE, Song AV, Halpern-Felsher BL. Predicting adolescent perceptions of the risks and benefits of cigarette smoking: a longitudinal investigation. *Health Psychol*. 2010;29(6):610–617.
- Weinstein ND. Testing four competing theories of health-protective behavior. *Health Psychol*. 1993;12(4):324–333.
- Lipkus IM, Kuchibhatla M, McBride CM, et al. Relationships among breast cancer perceived absolute risk, comparative risk, and worries. *Cancer Epidemiol Biomarkers Prev*. 2000;9(9):973–975.
- Park ER, Ostroff JS, Rakowski W, et al. Risk perceptions among participants undergoing lung cancer screening: baseline results from the National Lung Screening Trial. *Ann Behav Med*. 2009;37(3):268–279.

35. Chen LS, Kaphingst KA, Tseng TS, Zhao S. How are lung cancer risk perceptions and cigarette smoking related?—testing an accuracy hypothesis. *Transl Cancer Res.* 2016;5(suppl 5):S964–S971.
36. Persoskie A, Mao Q, Chou WY, et al. Absolute and comparative cancer risk perceptions among smokers in two cities in China. *Nicotine Tob Res.* 2014;16(6):899–903.
37. Kaufman AR, Koblitz AR, Persoskie A, et al. Factor structure and stability of smoking-related health beliefs in the National Lung Screening Trial. *Nicotine Tob Res.* 2016;18(3):321–329.
38. Alicke MD, Klotz ML, Breitenbecher DL, Yurak TJ, Vredenburg DS. Personal contact, individuation, and the better-than-average effect. *J Pers Soc Psychol.* 1995;68(5):804.
39. Klein WMP. Comparative risk estimates relative to the average peer predict behavioral intentions and concern about absolute risk. *Risk Decis Policy.* 2002;7(2):193–202.
40. Lyna P, McBride C, Samsa G, Pollak KI. Exploring the association between perceived risks of smoking and benefits to quitting: who does not see the link? *Addict Behav.* 2002;27(2):293–307.
41. National Cancer Institute. *A Socioecological Approach to Addressing Tobacco-Related Health Disparities.* NCI Tobacco Control Monograph Series 22. NIH Publication No. 17-CA-8035A. Bethesda, MD: US Department of Health and Human Services, National Institutes of Health, National Cancer Institute; 2017.
42. Chambers JR, Windschitl PD. Biases in social comparative judgments: the role of nonmotivated factors in above-average and comparative-optimism effects. *Psychol Bull.* 2004;130(5):813–838.
43. Helweg-Larsen M, Shepperd JA. Do moderators of the optimistic bias affect personal or target risk estimates? A review of the literature. *Pers Soc Psychol Rev.* 2001;5(1):74–95.
44. Sutton SR. How accurate are smokers' perceptions of risk? *Health Risk Society.* 1999;1(2):223–230.
45. Rose JP, Suls J, Windschitl PD. When and why people are comparatively optimistic about future health risks: the role of direct and indirect comparison measures. *Psychol Health Med.* 2011;16(4):475–483.
46. Rose JP. Are direct or indirect measures of comparative risk better predictors of concern and behavioural intentions? *Psychol Health.* 2010;25(2):149–165.
47. Ranby KW, Aiken LS, Gerend MA, Erchull MJ. Perceived susceptibility measures are not interchangeable: absolute, direct comparative, and indirect comparative risk. *Health Psychol.* 2010;29(1):20–28.
48. Loewenstein GF, Weber EU, Hsee CK, Welch N. Risk as feelings. *Psychol Bull.* 2001;127(2):267–286.
49. Slovic P, Peters E. Risk perception and affect. *Curr Dir Psychol Sci.* 2006;15(3):322–325.
50. Ferrer R, Klein WM. Risk perceptions and health behavior. *Curr Opin Psychol.* 2015;5:85–89.
51. Ferrer RA, Klein WMP, Avishai A, Jones K, Villegas M, Sheeran P. When does risk perception predict protection motivation for health threats? A person-by-situation analysis. *PLoS One.* 2018;13(3):e0191994.
52. Ferrer RA, Klein WM, Persoskie A, Avishai-Yitshak A, Sheeran P. The Tripartite Model of Risk Perception (TRIRISK): distinguishing deliberative, affective, and experiential components of perceived risk. *Ann Behav Med.* 2016;50(5):653–663.
53. Hay JL, Ramos M, Li Y, Holland S, Brennessel D, Kemeny MM. Deliberative and intuitive risk perceptions as predictors of colorectal cancer screening over time. *J Behav Med.* 2016;39(1):65–74.
54. Wilhelms EA, Fraenkel L, Reyna VF. Effects of probabilities, adverse outcomes, and status quo on perceived riskiness of medications: testing explanatory hypotheses concerning gist, worry, and numeracy. *Appl Cogn Psychol.* 2018;32(6):714–726.
55. Janssen E, Waters EA, van Osch L, Lechner L, de Vries H. The importance of affectively-laden beliefs about health risks: the case of tobacco use and sun protection. *J Behav Med.* 2014;37(1):11–21.
56. Magnan RE, Köblitz AR, Zielke DJ, McCaul KD. The effects of warning smokers on perceived risk, worry, and motivation to quit. *Ann Behav Med.* 2009;37(1):46–57.
57. Waters EA, Janssen E, Kaufman AR, et al. The relationship between young adult smokers' beliefs about nicotine addiction and smoking-related affect and cognitions. *J Cancer Educ.* 2016;31(2):338–347.
58. Janssen E, van Osch L, Lechner L, Candel M, de Vries H. Thinking versus feeling: differentiating between cognitive and affective components of perceived cancer risk. *Psychol Health.* 2012;27(7):767–783.
59. Diefenbach MA, Weinstein ND, O'Reilly J. Scales for assessing perceptions of health hazard susceptibility. *Health Educ Res.* 1993;8(2):181–192.
60. Wallsten TS, Budescu DV, Zwick R, Kemp SM. Preferences and reasons for communicating probabilistic information in verbal or numerical terms. *Bull Psychon Soc.* 1993;31(2):135–138.
61. Windschitl PD, Wells GL. Measuring psychological uncertainty: verbal versus numeric methods. *J Exp Psychol Appl.* 1996;2(4):343–364.
62. Bruine de Bruin W, Fischhoff B, Millstein SG, Halpern-Felsher BL. Verbal and numerical expressions of probability: "it's a fifty-fifty chance." *Organ Behav Hum Decis Process.* 2000;81(1):115–131.
63. Brewer NT, Tzeng JP, Lillie SE, Edwards AS, Peppercorn JM, Rimer BK. Health literacy and cancer risk perception: implications for genomic risk communication. *Med Decis Making.* 2009;29(2):157–166.
64. Waters EA, Hay JL, Orom H, Kiviniemi MT, Drake BF. "Don't know" responses to risk perception measures: implications for underserved populations. *Med Decis Making.* 2013;33(2):271–281.
65. Hay JL, Orom H, Kiviniemi MT, Waters EA. "I don't know" my cancer risk: exploring deficits in cancer knowledge and information-seeking skills to explain an often-overlooked participant response. *Med Decis Making.* 2015;35(4):436–445.
66. Orom H, Schofield E, Kiviniemi MT, et al. Low health literacy and health information avoidance but not satisfying help explain "Don't Know" responses to questions assessing perceived risk. *Med Decis Making.* 2018;38(8):1006–1017.
67. Shepperd JA, Helweg-Larsen M, Ortega L. Are comparative risk judgements consistent across time and events? *Pers Soc Psychol Bull.* 2003;29(9):1169–1180.
68. Hay JL, Ostroff J, Burkhalter J, Li Y, Quiles Z, Moadel A. Changes in cancer-related risk perception and smoking across time in newly-diagnosed cancer patients. *J Behav Med.* 2007;30(2):131–142.
69. Park ER, Gareen IF, Jain A, et al. Examining whether lung screening changes risk perceptions: National Lung Screening Trial participants at 1-year follow-up. *Cancer.* 2013;119(7):1306–1313.
70. Sheeran P, Harris PR, Epton T. Does heightening risk appraisals change people's intentions and behavior? A meta-analysis of experimental studies. *Psychol Bull.* 2014;140(2):511–543.
71. Weinstein ND. Smokers' recognition of their vulnerability to harm. In: Slovic P, ed. *Smoking: Risk, Perception, & Policy.* Thousand Oaks, CA: Sage Publications; 2001:81–96.
72. Diamantopoulos A, Sarstedt M, Fuchs C, Wilczynski P, Kaiser S. Guidelines for choosing between multi-item and single-item scales for construct measurement: a predictive validity perspective. *J Acad Mark Sci.* 2012;40(3):434–449.
73. Willis GB. *Cognitive Interviewing: A Tool for Improving Questionnaire Design.* Thousand Oaks, CA: Sage Publications; 2005.
74. Bradburn NM, Sudman S, Wansink B. *Asking Questions: The Definitive Guide to Questionnaire Design—For Market Research, Political Polls, and Social and Health Questionnaires.* Hoboken, NJ: John Wiley & Sons; 2004.
75. Dillman DA. *Mail and Internet Surveys: The Tailored Design Method—2007 Update With New Internet, Visual, and Mixed-Mode Guide.* Hoboken, NJ: John Wiley & Sons; 2007.
76. Pepper JK, Emery SL, Ribisl KM, Rini CM, Brewer NT. How risky is it to use e-cigarettes? Smokers' beliefs about their health risks from using novel and traditional tobacco products. *J Behav Med.* 2015;38(2):318–326.
77. Persoskie A, Nguyen AB, Kaufman AR, Tworek C. Criterion validity of measures of perceived relative harm of e-cigarettes and smokeless tobacco compared to cigarettes. *Addict Behav.* 2017;67:100–105.
78. Popova L, Ling PM. Perceptions of relative risk of snus and cigarettes among US smokers. *Am J Public Health.* 2013;103(11):e21–e23.
79. Wackowski OA, Bover Manderski MT, Delnevo CD. Comparison of direct and indirect measures of e-cigarette risk perceptions. *Tob Regul Sci.* 2016;2(1):38–43.