Smoking Cessation and Tobacco-related Risk Perceptions among People with and without a Diagnosis of Cancer

Stephanie R. Land[1], Laura Baker[2], Jenny Twesten[2], Carolyn M. Reyes-Guzman[1], and Annette R. Kaufman[1]

ABSTRACT

Background: Little is known about how cancer diagnosis and tobacco-related risk perceptions are associated with smoking behavior.

Methods: We used data from Waves (W) 1–3 (2013–2016) of the Population Assessment of Tobacco and Health Study to analyze longitudinal smoking behavior among adults who were current smokers and not previously diagnosed with cancer at baseline (W1; $N = 7{,}829$). The outcome was smoking cessation as of follow-up (W3). Explanatory variables were sociodemographics, other tobacco product use, adult at first cigarette, tobacco dependence, cancer diagnosis after baseline, and tobacco-related risk perceptions [cigarette harm perception, worry that tobacco products will damage one's health ("worry"), belief that smoking causes cancer ("belief"), and nondaily smoking harm perception].

Results: Cessation was significantly associated with baseline worry (OR = 1.26; 95% confidence interval, 1.13–1.40), follow-up cigarette harm perception [OR = 2.01 (1.77–2.29)], and follow-up belief [OR = 1.40 (1.20–1.63)]. Cessation was inversely associated with follow-up (W3) worry, and this association was stronger among those without a cancer diagnosis (OR = 0.37 without cancer; OR = 0.76 among individuals diagnosed with cancer; interaction $P = 0.001$).

Conclusions: Cessation is associated with tobacco-related risk perceptions, with different perceptions contributing in unique ways. Cessation is predicted by baseline worry but is inversely associated with worry at follow-up, suggesting that perhaps cessation has alleviated worry. The latter finding was stronger among respondents not diagnosed with cancer.

Impact: Associations between cancer diagnosis, tobacco-related risk perceptions, and smoking behavior may inform the development of evidence-based smoking cessation interventions.

Introduction

Cigarette smoking remains an important public health challenge, with 12.6% of U.S. adults currently smoking as of 2020 (1). Smoking-related risk perceptions, which are thoughts and feelings about the harm associated with cigarette smoking (2), may be important when considering smoking behavior. For example, results from the National Survey on Drug Use and Health showed that smoking-related risk perceptions were highest among former and never-smokers, lower among nondaily smokers compared with former and never-smokers, and lowest among daily smokers compared with other groups (3). Risk perceptions are multidimensional. For example, the Tripartite Model of Risk Perception has three components: experiential, affective, and deliberative. Affective risk perceptions, such as worry, have been shown to influence intentions to engage in preventive behavior, such as smoking cessation, and are independent predictors of health behaviors (4–7).

Approximately 20% to 30% of patients newly diagnosed with cancer report current cigarette smoking (8). Cessation after cancer diagnosis improves prognosis (9, 10). Fortunately, studies have suggested that smokers with a recent diagnosis of cancer are more likely to quit smoking compared with smokers not diagnosed with cancer (e.g., 2-year quit rate, 31% vs. 20%) even for cancers less strongly linked to smoking (11). Unfortunately, the majority of smokers diagnosed with cancer—up to 60% to 70%—continue to smoke after their diagnosis (12–14). Current smoking prevalence among cancer survivors was 13.3% in 2019 (15). In a study of survivors 9 years after diagnosis, 9.3% were current smokers (16). Few studies have collected longitudinal data among patients with cancer to evaluate trajectories of risk perceptions and smoking behavior over time. In a longitudinal observational study of 188 patients newly diagnosed with a tobacco-related cancer, patients' cancer-related risk perception was assessed at 3 and 12 months after surgical resection. Higher perceived risk at 3 months was associated with smoking cessation by 12 months (17). Furthermore, for patients who quit smoking, perceived risk at 12 months was lower than for patients who continued smoking, consistent with the risk-reappraisal hypothesis, which asserts that behaviors to reduce risk of negative outcomes will result in lowered risk perception (18). Those who quit smoking but subsequently relapsed were *most likely* (compared with those who continued smoking or who maintained cessation) to see themselves at greater risk 1 year later (17). Another study showed that perceptions of the risks of continued smoking can influence quitting behavior among cancer survivors (19). Taken together, these results suggest possible associations between tobacco-related risk perceptions (i.e., risk perceptions related to smoking or other tobacco use), cancer diagnosis, and smoking behavior.

To our knowledge, no current research has used a nationally representative U.S. sample to analyze tobacco-related risk perceptions and smoking cessation, comparing adults with and without a cancer diagnosis. To address this research gap, we used data from the Population Assessment of Tobacco and Health (PATH) Study, a nationally representative, longitudinal study (20). Our aim was to examine, among respondents who had not been diagnosed with cancer and were current cigarette smokers at baseline (Wave 1), whether

[1]Tobacco Control Research Branch, NCI, Bethesda, Maryland. [2]The Bizzell Group, LLC, New Carrollton, Maryland.

C.M. Reyes-Guzman and A.R. Kaufman contributed equally to this article.

Corresponding Author: Stephanie R. Land, NCI, 9609 Medical Center Drive, Rockville, MD 20892. Phone: 240-276-6946; E-mail: stephanie.land@nih.gov

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smoking cessation at follow-up (Wave 3) was more likely to occur among those who were diagnosed with cancer at a subsequent wave (compared with individuals who did not experience a cancer diagnosis) and whether cessation likelihood differed according to tobacco-related risk perceptions. In the current study, tobacco-related risk perceptions include worry about harm to oneself and smoking-related beliefs and perceptions of harm to people in general. We hypothesized that those diagnosed with cancer would be more likely to quit smoking and that the likelihood of cessation might be moderated by tobacco-related risk perceptions both before and after the cancer diagnosis. The rationale for testing these interactions is that the experience of cancer might have different effects on cessation depending on an individual's beliefs and perceptions about the harms of cigarette smoking. For example, for an individual who believes that smoking causes cancer, a diagnosis might prompt cessation, whereas for an individual who does not believe that smoking causes cancer, a diagnosis might be less likely to prompt cessation.

Materials and Methods

Participants

The PATH Study collects data regarding tobacco use behaviors and related health outcomes in a longitudinal cohort of U.S. adults (ages ≥18) and youths (ages 12–17). PATH uses English and Spanish audio computer-assisted self-interviews. For Wave 1, the recruitment used stratified, address-based, area-probability sampling. Tobacco users, young adults (ages 18–24), and Black adults were oversampled. More information regarding the study, including questionnaires and interview procedures, sampling and weighting, and instructions for accessing the data, is published elsewhere (20, 21). The current analyses included all adult public use data from respondents who provided data in Waves 1–3 (collected from 2013 to 2016), did not report a history of cancer at Wave 1, and were current cigarette smokers at Wave 1 ($N = 7{,}829$). Analyses were conducted from 2020 to 2022. We refer to Wave 1 as "baseline" and Wave 3 as "follow-up." These data are deidentified and publicly available. This study was exempt from Institutional Review Board review.

Measures

Demographics (baseline)

Variables analyzed were age, sex, race/ethnicity, education, household income, employment status, and geographic region, categorized according to the PATH public use data. Detailed descriptions of these variables have been reported elsewhere (20).

Tobacco-related risk perceptions (baseline and follow-up)

Using items shown in **Table 1**, four measures of tobacco-related risk perception were used:

(i) Cigarette harm perception ("How harmful do you think cigarettes are to health?" 1 = Not at all harmful, 2 = Slightly harmful, 3 = Somewhat harmful, 4 = Very harmful, 5 = Extremely harmful).

(ii) Worry that tobacco products will damage one's health ("To what extent, if at all, are you worried that using tobacco products will damage your health in the future?" 1 = Not at all worried, 2 = A little worried, 3 = Moderately worried, 4 = Very worried). At follow-up, the question specified "tobacco including e-cigarettes or other electronic nicotine products."

(iii) Belief that smoking causes cancer. At baseline (Wave 1), respondents were asked: "Based on what you know or believe, does smoking cause (lung/bladder/mouth) cancer in smokers?" (1 = Yes, 2 = No). The Wave 3 PATH Study included liver cancer, and the items were framed as a measure of agreement (1 = Strongly agree, 2 = Agree, 3 = Neither agree nor disagree, 4 = Disagree, 5 = Strongly disagree). For our analyses, items were reverse coded so that high scores indicated agreement. The mean level of agreement with these items capturing beliefs for specific cancer sites was calculated.

(iv) Nondaily smoking harm perception (follow-up). ("How much do you think people harm themselves when they smoke cigarettes some days but not every day?" 1 = No harm, 2 = A little harm, 3 = Some harm, 4 = A lot of harm). Nondaily smoking harm perception was not included in the Wave 1 PATH Study.

Tobacco-related risk perceptions were included as continuous covariates in the statistical models.

Cancer diagnosis (between baseline and follow-up)

The binary variable cancer diagnosis indicates a diagnosis within 12 months at Wave 2 or 3 ["In the past 12 months, have you been told by a doctor, nurse, or other health professional that you had cancer?" (1 = Yes, 2 = No)]. This is the only Wave 2 variable. Missing responses at Waves 2–3 were imputed as "No" for 10 participants who reported that they had not seen a doctor, nurse, or other health professional within 12 months.

Tobacco use

Cigarette smoking (baseline and follow-up)

Analyses included only respondents who were established, current smokers at baseline based on the PATH-derived variable (having ever smoked a cigarette, having smoked more than 100 cigarettes in lifetime, and currently smoking every day or some days; 1 = Yes, 2 = No). Respondents were considered to have quit smoking if they reported being noncurrent smokers at follow-up.

Adult at first cigarette and other tobacco use (baseline)

Respondents were defined as adults at the time of their first cigarette if they reported age ≥ 18 in response to "How old were you the first time you smoked part or all of a cigarette?" The use of other tobacco products was dichotomous, defined as current every day or some day use of e-cigarettes, pipes, hookah, dissolvable tobacco, traditional cigars, filtered cigars, cigarillos, or smokeless tobacco products.

Tobacco dependence (baseline)

Tobacco dependence was measured using a 16-item composite scale, previously validated by Strong and colleagues (22), consisting of 11 items from the Wisconsin Inventory of Smoking Dependence Motives, four items from the Nicotine Dependence Syndrome Scale, and one item from the American Psychological Association's Diagnosis and Statistical Manual of Mental Disorders measure for Impaired Control. Responses to each question were converted to scores ranging from 0 to 2. Items were multiplied by 50 and averaged to obtain a mean tobacco dependence score ranging from 0 to 100, with higher scores representing higher levels of dependence.

Motivation to quit (baseline)

Motivation to quit using tobacco products was assessed with the question: "Overall, on a scale from 1 to 10 where 1 is not at all interested and 10 is extremely interested, how interested are you in quitting [tobacco products]? Please enter a number from 1 to 10."

Table 1. Tobacco-related risk perception items.

Measure	Baseline survey item	Follow-up survey item
Cigarette harm perception	How harmful do you think cigarettes are to health? 1 = Not at all harmful 2 = Slightly harmful 3 = Somewhat harmful 4 = Very harmful 5 = Extremely harmful	How harmful do you think cigarettes are to health? 1 = Not at all harmful 2 = Slightly harmful 3 = Somewhat harmful 4 = Very harmful 5 = Extremely harmful
Worry that tobacco products will damage one's health	To what extent, if at all, are you worried that [using/your past use of] tobacco products will damage your health in the future? 1 = Not at all worried 2 = A little worried 3 = Moderately worried 4 = Very worried	To what extent, if at all, are you worried that [using/your past use of] tobacco[, including e-cigarettes or other electronic nicotine products] will damage your health in the future? 1 = Not at all worried 2 = A little worried 3 = Moderately worried 4 = Very worried
Belief that smoking causes cancer	Based on what you know or believe, does smoking cause...	Based on what you believe, how much do you agree or disagree with the following statements? Smoking can cause...
	...Lung cancer in smokers? 1 = Yes 2 = No	...Lung cancer in smokers. 1 = Strongly agree, 2 = Agree, 3 = Neither agree nor disagree, 4 = Disagree, 5 = Strongly disagree
	...Bladder cancer in smokers? 1 = Yes 2 = No	...Bladder cancer in smokers. 1 = Strongly agree, 2 = Agree, 3 = Neither agree nor disagree, 4 = Disagree, 5 = Strongly disagree
	...Mouth cancer in smokers? 1 = Yes 2 = No	...Mouth cancer in smokers. 1 = Strongly agree, 2 = Agree, 3 = Neither agree nor disagree, 4 = Disagree, 5 = Strongly disagree
	—	...Liver cancer in smokers. 1 = Strongly agree, 2 = Agree, 3 = Neither agree nor disagree, 4 = Disagree, 5 = Strongly disagree
Nondaily smoking harm perception	—	How much do you think people harm themselves when they smoke cigarettes some days but not every day? 1 = No harm 2 = A little harm 3 = Some harm 4 = A lot of harm

Note: For details about all of the items, see codebook for the adult questionnaire (46).

Statistical analysis

Descriptive statistics are unweighted frequencies and weighted percentages calculated using Waves 1–3 "all-wave" longitudinal survey weights. We fit a weighted logistic regression model for smoking cessation. The full model included all demographics listed above, tobacco-related risk perceptions, adult at the time of first cigarette, other tobacco product use, tobacco dependence, diagnosis of cancer, and interactions between cancer diagnosis and tobacco-related risk perception variables. To select the final logistic regression model, backward elimination was used with $P > 0.5$ as the criterion (23). We used balanced repeated replication variance estimation method with Fay's adjustment set to 0.3 (24, 25). PATH survey weights account for selection bias caused by loss to follow-up. The logistic regression excluded participants with missing data for any covariate. Characteristics of respondents with complete data ($N = 7{,}069$) and respondents who were not included in the final model due to missing data ($N = 760$) are shown in Supplementary Table S1; differences between the characteristics of participants included in and excluded from the final model were assessed with χ^2 tests (categorical variables) and t tests (continuous variables) using the SAS survey procedures.

As a supplementary analysis, we used the same approach as the primary analysis to fit a separate weighted logistic regression model with motivation to quit included as an independent variable. This variable was excluded from the primary analysis due to a high level of missingness. [The PATH Wave 1 questionnaire states that this question was skipped incorrectly for respondents who were current tobacco users who had not attempted to quit or cut down tobacco use in the past 12 months (26).]

Effects were considered significant for $P < 0.05$. For variables involved in interactions, effects for combinations of interacting variables, using exemplar values for continuous variables, are reported. That is, in the case of an interaction between variables X1 and X2, with X1 (and possibly also X2) continuous, the effects of X2 are given for two fixed values of X1. Analyses were conducted with SAS version 9 and SUDAAN version 11.0.1 (RTI).

Data availability

The data analyzed in this study were obtained from the Inter-university Consortium for Political and Social Research at https://doi.org/10.3886/ICPSR36498.v16.

Results

In the analytic sample ($N = 7{,}829$), 25.5% were ages 25 to 34, 56.1% were male, 69.2% were non-Hispanic White, 34.1% had some college education, 25.4% had annual household income of $10,000 to $24,999, 47.4% were employed full time, 39.8% resided in the South, 21.8% were adults at the time of first cigarette, and 43.9% used other tobacco

Table 2. Baseline participant characteristics for the analytic sample ($N = 7,829$).

	No. (Weighted %)
Age, years	
18–24	1,684 (14.8)
25–34	1,822 (25.5)
35–44	1,446 (19.5)
45–54	1,456 (19.8)
55–64	1,019 (14.3)
≥65	400 (6.1)
Sex	
Male	4,001 (56.1)
Female	3,826 (43.9)
Race/ethnicity	
White, non-Hispanic	5,031 (69.2)
Black, non-Hispanic	1,112 (13.3)
Other, non-Hispanic	551 (6.0)
Hispanic	1,020 (11.5)
Educational attainment	
<High school	1,317 (15.7)
GED	858 (10.5)
High school graduate	1,974 (28.2)
Some college (no degree) or associate's degree	2,821 (34.1)
Bachelor's degree	622 (9.2)
Advanced degree	207 (2.4)
Household income, $	
<10,000	1,724 (19.5)
10,000–24,999	2,102 (25.4)
25,000–49,999	1,792 (23.2)
50,000–99,999	1,202 (17.2)
≥100,000	442 (6.5)
Missing	567 (8.2)
Employment status	
Works full time at least 35 hours per week	3,454 (47.4)
Works part time at least 15 to 34 hours per week	955 (11.2)
Works part time less than 15 hours per week	373 (4.5)
Does not currently work for pay	3,008 (36.9)
U.S. region	
Northeast	1,143 (17.5)
Midwest	2,193 (24.4)
South	3,062 (39.8)
West	1,431 (18.3)
Adult at first cigarette	
Not adult (ages <18 years)	6,160 (78.3)
Adult (ages ≥18 years)	1,666 (21.8)
Use of other tobacco products	
Yes	3,423 (43.9)
No	4,150 (56.1)
	Median (range)
Tobacco dependence	53.8 (0.0–100.0)
Motivation to quit	7.4 (0.0–10.0)

Table 3. Longitudinal participant characteristics for the analytic sample ($N = 7,829$).

	Baseline No. (Weighted %)	Follow-up No. (Weighted %)
Cancer diagnosis		
Cancer	0	150 (1.9)
No cancer	7,829 (100)	7,649 (98.1)
Smoking		
Not a current smoker	0	1,181 (15.3)
Nondaily smoker	1,624 (20.7)	1,171 (15.0)
Daily smoker	6,205 (79.3)	5,472 (69.7)
Tobacco-related risk perceptions	**Median (range)**	**Median (range)**
Cigarette harm perception	3.7 (1.0–5.0)	3.6 (1.0–5.0)
Worry that tobacco products will damage one's health	2.2 (1.0–4.0)	1.9 (1.0–4.0)
Belief that smoking causes cancer[a]	0.6 (0.0–1.0)	3.9 (1.0–5.0)
Nondaily smoking harm perception	N/A	2.7 (1.0–4.0)

[a]Scale for the belief that smoking causes [lung/bladder/mouth] cancer (baseline) and the belief that smoking causes [lung/bladder/mouth/liver] cancer (follow-up).

products in addition to cigarettes (**Table 2**). Median tobacco dependence and motivation to quit were 53.8 and 7.4, respectively. In addition, 79.3% and 20.7% smoked daily and nondaily, respectively (**Table 3**). A total of 150 respondents (1.9%) received a cancer diagnosis (**Table 3**); 24 (17%) of those respondents quit smoking. At follow-up, 69.7% and 15.0% smoked daily and nondaily, respectively, and 15.3% were not currently smoking (**Table 3**). Supplementary Table S2 provides the cross-tabulation of smoking status at baseline and follow-up.

In the final logistic regression, cessation was significantly associated with baseline worry that tobacco products will damage one's health [OR = 1.26; 95% confidence interval (CI), 1.13–1.40], follow-up cigarette harm perception [OR = 2.01 (1.77–2.29)], follow-up belief that smoking causes cancer [OR = 1.40 (1.20–1.63)] and follow-up nondaily harm perception [OR = 1.37 (1.22–1.54)] (**Table 4**). There was also a significant interaction between worry at follow-up and cancer diagnosis ($P = 0.001$). The odds of cessation were inversely associated with worry, and this inverse association was much stronger among participants without a cancer diagnosis (OR = 0.37 for every one-point increase in worry among those without cancer; OR = 0.76 for every one-point increase in worry among those with cancer). The interaction can also be presented in terms of the associations of cessation with cancer diagnosis for exemplar values of worry: among respondents with a low level of worry (worry = 1) at follow-up, those who were diagnosed with cancer were less likely to have quit smoking than those without cancer (OR = 0.63), whereas among those with a high level of worry (worry = 4), those with cancer were more likely to have quit smoking (OR = 5.56). Estimates with confidence intervals for this interaction are provided in **Table 4** and **Fig. 1**. Sex, race/ethnicity, education, income, and use of other tobacco products were significantly associated with cessation. The association with age was significant and convex, with the youngest (ages 18–24) and oldest (ages 65+) groups having the highest likelihood of cessation. A higher level of tobacco dependence was associated with decreased likelihood of cessation. Employment and baseline cigarette harm perception did not reach $P < 0.5$ in the preliminary full model and were therefore not included in the final model. Geographic region and adult at time of first cigarette, and the interaction of cancer with baseline belief that smoking causes cancer did not significantly predict cessation in the final model.

In supplementary analysis, motivation to quit significantly predicted cessation [OR = 1.05 (1.01–1.09)]. Other estimated effects were largely consistent with the primary model (Supplementary Table S3).

Discussion

The main effects of our analyses contribute to research about tobacco-related risk perceptions and smoking behavior in the general

Table 4. Association of smoking cessation at follow-up with sociodemographics, tobacco use, tobacco-related risk perceptions, and cancer diagnosis.

Variable		OR (95% CI) *(N = 7,069)*	*P*
Tobacco-related risk perceptions (baseline)	Worry that tobacco products will damage one's health	1.26 (1.13–1.40)	<0.001
Tobacco-related risk perceptions (follow-up)	Cigarette harm perception	2.01 (1.77–2.29)	<0.001
	Belief that smoking causes cancer	1.40 (1.20–1.63)	<0.001
	Nondaily smoking harm perception	1.37 (1.22–1.54)	<0.001
Interactions		**Least squares mean Odds (95% CI)**	
Cancer x Worry that tobacco products will damage one's health (follow-up)	Noncancer, worry = 1 (low)	0.62 (0.49–0.77)	.001
	Cancer, worry = 1	0.39 (0.18–0.85)	
	Noncancer, worry = 4 (high)	0.03 (0.02–0.04)	
	Cancer, worry = 4	0.17 (0.07–0.40)	
Cancer x Belief that smoking causes cancer (baseline)	Noncancer, belief = 0 (low)	0.19 (0.13–0.27)	0.28
	Cancer, belief = 0	0.84 (0.22–3.23)	
	Noncancer, belief = 1 (high)	0.12 (0.1–0.15)	
	Cancer, belief = 1	0.18 (0.09–0.39)	
Sociodemographics		**OR (95% CI)**	
Age	18–24	0.73 (0.48–1.11)	.003
	25–34	0.64 (0.43–0.94)	
	35–44	0.57 (0.39–0.84)	
	45–54	0.57 (0.39–0.83)	
	55–64	0.79 (0.53–1.19)	
	≥65	1 (Reference)	
Sex	Male	1.18 (1.01–1.39)	.04
	Female	1 (Reference)	
Race/ethnicity	White, non-Hispanic	0.83 (0.64–1.07)	.03
	Black, non-Hispanic	0.55 (0.37–0.81)	
	Other, non-Hispanic	0.95 (0.60–1.52)	
	Hispanic	1 (Reference)	
Educational attainment	<High school	0.43 (0.27–0.70)	.001
	GED	0.48 (0.30–0.77)	
	High school graduate	0.53 (0.34–0.81)	
	Some college (no degree) or associate's degree	0.73 (0.48–1.11)	
	Bachelor's degree	0.82 (0.54–1.24)	
	Advanced degree	1 (Reference)	
Household income	<10,000	0.38 (0.27–0.52)	<0.001
	10,000–24,999	0.62 (0.44–0.87)	
	25,000–49,999	0.55 (0.40–0.77)	
	50,000–99,999	0.77 (0.55–1.06)	
	≥100,000	1 (Reference)	
	Missing	0.54 (0.35–0.85)	
Region	Northeast	0.80 (0.60–1.07)	.38
	Midwest	0.90 (0.72–1.13)	
	South	0.86 (0.69–1.06)	
	West	1 (Reference)	
Adult at first cigarette	Not adult (ages <18 years)	1 (Reference)	.07
	Adult (ages ≥18 years)	1.23 (0.99–1.53)	
Use of other tobacco products	Yes	1.25 (1.04–1.51)	.02
	No	1 (Reference)	
Tobacco dependence	Tobacco dependence	0.985 (0.982–0.989)	<0.001

population. Respondents with greater follow-up cigarette harm perception, belief that smoking causes cancer, and nondaily smoking harm perception were more likely to have quit smoking. Those items regarded harm to people in general, whereas worry regarded harm to the respondent's own health. Respondents with greater baseline worry that tobacco products will damage one's (the respondent's own) health were significantly more likely to subsequently quit smoking. How people think about risks is important, and research has shown that how people feel about risks is also important and distinct from how people think about them. Worry has also been found to interact with (moderate) the associations between other tobacco-related risk perceptions and tobacco use behavior in the general population (27). In our analyses, the tobacco-related risk perception components—beliefs, perception of harm, and worry—predicted unique variance in behavior. The multidimensional nature of risk perceptions has been demonstrated through other research in health behavior (4–7, 27) and specifically in smoking behavior (2).

Our analysis included PATH Study participants with and without a diagnosis of cancer, revealing differences between those groups and advancing our understanding of the associations among cancer

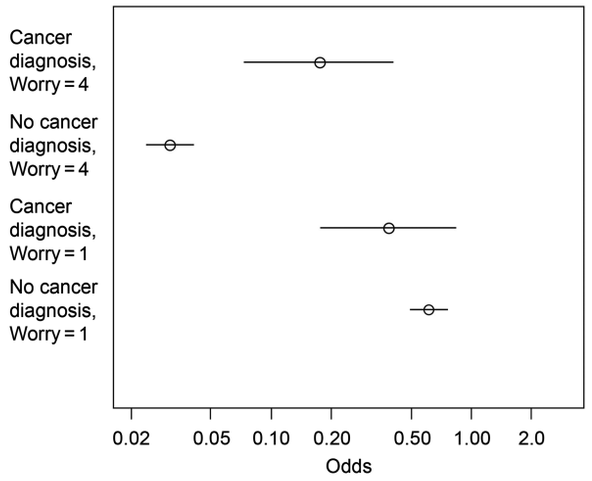

Figure 1.

Odds of cessation by cancer diagnosis and worry at follow-up. The interaction between cancer diagnosis and follow-up worry is demonstrated using two exemplar values of worry (high worry = 4 and low worry = 1). The lowest odds of cessation are seen in respondents who have not been diagnosed with cancer and whose worry is high.

diagnosis, risk perceptions, and smoking behavior. We found a significant interaction between cancer diagnosis (incident cancer diagnosis between baseline and follow-up) and follow-up worry that tobacco products will damage one's health. We found lower odds of cessation associated with higher follow-up worry, and this inverse association was stronger in the absence of cancer diagnosis. This finding may reflect reverse causation. Respondents are worried because they have not quit smoking and have not yet been diagnosed with cancer; therefore, cancer remains a threat. The interaction may indicate that those who are diagnosed with cancer remain worried about the effects of tobacco on their future health, even if they have quit (and therefore the association of worry and cessation is weaker), whereas among those not diagnosed with cancer, quitting alleviates the worry. Cognitive dissonance may be at play; some individuals with cancer diagnoses may maintain lower worry that tobacco products will damage their health, which then undermines cessation. There may also be forward causation if, among individuals with lower worry that tobacco products will damage one's health, cancer diagnosis does not compel cessation. Indeed, the traumatic experience of a cancer diagnosis may actually deter cessation, whereas among individuals with higher worry, a cancer diagnosis may motivate cessation. The current study suggests that affective tobacco-related risk perceptions may be important to monitor and address, particularly among cancer survivors. Affect and risk perceptions are two components of the teachable moment heuristic, which may hold promise for designing cessation interventions at cancer diagnosis (28). Future research should seek to increase our understanding of the reasons underlying these beliefs and risk perceptions, and how they may influence behavior.

Improved cessation support for patients with cancer and survivors is needed (29–31). A separate analysis revealed that among survivors at baseline in PATH, unassisted quit attempts resulted in the lowest odds of cessation (adjusted OR = 0.39) versus other methods (32). Patients are receptive to oncology providers' advice to quit (33). However, oncology clinicians report concerns about their ability to intervene and concerns about patient resistance to treatment (34). NCI-designated cancer centers in the United States have recently made considerable progress in the development of cessation services, in part due to the NCI Cancer Center Cessation Initiative (35–37). One recent clinical trial demonstrated the potential for effective interventions in this population (38). However, most patients with cancer who smoke will require more than one quit attempt to succeed, even with comprehensive tobacco dependence programs (39).

Information about the risks continued smoking may have for cancer and its treatment may increase motivation to quit (40). Surprisingly, a separate study by our team found that among PATH participants who smoked at follow-up, those who had been diagnosed with cancer did not have significantly different tobacco-related risk perceptions than participants who had not been diagnosed, accounting for sociodemographics (41). Furthermore, cancer survivors may not be aware that continued smoking has a negative impact on cancer outcomes (42, 43). In the current study, 61 of 149 (weighted 38.7%) of individuals who were diagnosed with cancer believed that smoking is not at all/slightly/somewhat harmful to health, indicating that better risk communications may be needed even in the survivor population. Survivors are receptive to receiving risk-related information from their oncology providers (40, 44), although patients prefer to receive a balance of information, including risks of smoking and benefits of cessation (45). Conversations with providers can improve patients' awareness of the effects of smoking on cancer treatment (33).

Limitations

Our analysis is based on self-reported smoking status and does not consider the receipt of cessation treatment. The tobacco-related risk perception items in PATH were limited in number and scope, and the only one that asked about the participant's personal risk was worry. The other tobacco-related risk perception items asked about general perceptions of harm. Future studies should consider including more items to comprehensively assess tobacco-related risk perceptions. However, the PATH Study is the only nationally representative longitudinal study that assesses tobacco use with a comprehensive battery of tobacco-related constructs, making it very useful for the current study. In addition, the percentage of the analytic sample diagnosed with cancer was small (2%), although the absolute number of patients diagnosed was 150. Statistical power to test interactions between cancer diagnosis and tobacco-related risk perceptions was not strong, and so these analyses cannot rule out those interactions that were not significant. The cancer belief item changed from baseline to follow-up; at follow-up, liver cancer was added and responses were Likert type, whereas at baseline, responses were yes/no. These should be viewed as distinct items. Another limitation is that 9.7% of the sample was excluded from the primary analysis due to missing data. There were significant differences between included versus excluded respondents. The weights are designed to produce results that are representative of the population, and including important explanatory variables in the model should reduce the effect of any selection bias on model estimates. Finally, we used data collected through October 2016 (Waves 1–3). We elected not to use more recent data because we determined that attrition would diminish the statistical power and generalizability, outweighing the benefit of recency.

There are important associations between tobacco-related risk perceptions and smoking cessation. Furthermore, associations between cancer diagnosis and smoking cessation are complex and differ by tobacco-related risk perceptions. Communication strategies informed by these associations may be incorporated into the development of evidence-based smoking cessation interventions.

Authors' Disclosures

J. Twesten reports other support from NCI during the conduct of the study. No disclosures were reported by the other authors.

Disclaimer

The views and opinions expressed in this article are those of the authors only and do not necessarily represent the views, official policy, or position of HHS or any of its affiliated institutions or agencies.

Authors' Contributions

S.R. Land: Conceptualization, resources, data curation, software, formal analysis, supervision, validation, investigation, visualization, methodology, writing–original draft, project administration, writing–review and editing. **L. Baker:** Data curation, software, formal analysis, validation, writing–review and editing. **J. Twesten:** Supervision, investigation, project administration, writing–review and editing. **C.M. Reyes-Guzman:** Conceptualization, resources, data curation, software, formal analysis, investigation, visualization, methodology, writing–original draft, writing–review and editing. **A.R. Kaufman:** Conceptualization, data curation, investigation, visualization, methodology, writing–original draft, writing–review and editing.

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Note

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