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Conditional risk assessment of adolescents' electronic cigarette perceptions

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Abstract

Objectives—Adapt an established instrument for measuring adolescents' cigarette-related perceptions for new application with electronic cigarettes (e-cigarettes).

Methods—In this exploratory study, 104 male high school students (40% tobacco ever-users) estimated the probability of potential e-cigarette risks (eg, lung cancer) or benefits (eg, look cool). We calculated associations between risk/benefit composite scores, ever-use, and use intention for e-cigarettes and analogously for combustible cigarettes.

Results—E-cigarette ever-use was associated with lower perceived risks, with adjusted differences versus never-users greater for e-cigarettes than cigarettes. Risk composite score was inversely associated, and benefit score positively associated, with e-cigarette ever-use and use intention.

Conclusion—Conditional risk assessment characterized adolescents' perceived e-cigarette risk/benefit profile, with potential utility for risk-perception measurement in larger future studies.

Keywords

behavior; epidemiology; youth tobacco use

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Human Subjects Statement

An institutional review board at the University of California San Francisco approved all study procedures (study number: 13-11452).

Conflict of Interest Statement

The authors report that they have no conflicts of interest related to this publication.

How individuals perceive the potential positive and negative consequences of their actions is an important component of health decision models and a key predictor of future behavior and behavioral intentions.^{1,2} Among adolescents, perceived risks and benefits have both been associated with intentions to engage in risk-taking,³ including the use of illegal drugs and other substances.^{4,5} Measurement instruments that capture adolescents' perceptions provide data that offer insight into the decision-making process regarding health behaviors, which can lead to more effective health promotion.

In the US, about 6000 people per day smoke cigarettes for the first time, and individuals under age 18 years account for about half of new users.⁶ Among high school students, those who have smoked cigarettes estimate lower probabilities of negative consequences and higher probabilities of positive social returns related to smoking.⁷ Moreover, lower levels of perceived smoking-related risks and higher levels of perceived benefits are associated with subsequent smoking initiation among adolescent non-smokers.⁸ Among adolescent smokers, lower perceived risks correspond to greater promotion of smoking among their peers.⁹ Thus, understanding adolescents' risk and benefit perceptions related to cigarette use has implications for creating more effective, evidence-based anti-smoking interventions and regulations that target perception formation.

However, cigarettes account for only a portion of adolescent tobacco use. While cigarette smoking is declining among US high school male students,¹⁰ there is increasing use of alternative tobacco products; in particular, electronic cigarette use is rising rapidly.¹⁰⁻¹³ Some adolescents who have tried electronic cigarettes have never smoked cigarettes,¹⁴ suggesting that adolescents may initiate tobacco use with electronic cigarettes. The health impact of growing electronic cigarette popularity among youth is largely unknown¹⁵ but increasingly stated as a public health concern.^{16,17} With neither a scientific nor popular consensus as to long-term effects, adolescents' reliance on their own risk and benefit perceptions may take on greater importance in their decision to use electronic cigarettes.

Scant published data exist with regard to measuring adolescent risk perceptions in the context of electronic cigarettes. Recent studies have asked adolescents and/or young adults to compare the overall harm of electronic cigarettes to cigarettes. In Poland, more than half of high school and university survey respondents believed that electronic cigarettes were safer than conventional cigarettes.¹¹ Among college and university students in Hawaii, lower electronic cigarette harm perceptions were correlated with past-30 day electronic cigarette use and with greater receptivity to electronic cigarette marketing.¹⁸ Among US middle and high school students, current cigarette smokers were more likely than never-smokers to rate electronic cigarettes as less harmful than cigarettes.^{19,20} In one prospective study, both among cigarette smokers and non-smokers, young adults who perceived electronic cigarettes to be less harmful than cigarettes were more likely to try electronic cigarettes at 6-month follow-up.²¹ While providing valuable insights, these studies relied on unconditional measures of perceived risk, in which participants were asked to assess electronic cigarettes generally, without any context to anchor potential electronic cigarette use to what they might experience personally.

In contrast, conditional risk assessment, in which participants are asked to consider future outcomes under the condition, often hypothetical, that they engage in a particular behavior (eg, “What is the chance you will get sick *if* you were to smoke daily?”), has been shown to be a superior indicator of behavior.^{7,22} Furthermore, indirect risk comparison items, in which stand-alone risks or benefits of various tobacco products are assessed in separate questions, could reveal underlying differences in beliefs more readily than direct comparison items, in which participants are asked about products side-by-side and in relation to each other.²³ Finally, measures that ask participants to consider multiple outcomes, including health risks and social risks, as well as possible benefits, yield a more detailed inventory of the expectations potentially shaping tobacco-related behaviors than would measures that assess perceived harm in general.⁷

The primary objective of this study was to adapt an instrument previously validated for measuring adolescent risk and benefit perceptions related to cigarettes for application in measuring adolescent risk and benefit perceptions related to electronic cigarettes. We hypothesize that the new conditional risk assessment instrument will effectively measure multiple perceived risks and benefits related to electronic cigarettes and that these perceptions will be associated with reported behavior. Specifically, based on prior theory^{1,2} and analogous to associations demonstrated for cigarettes,^{7,8} we anticipate lower perceived probability of future risks and higher perceived probability of future benefits among ever-users compared to never-users of electronic cigarettes, as well as lower perceived risks and higher perceived benefits among never-users who report intention to use electronic cigarettes in the future. Our expectation is that this adapted conditional risk assessment instrument will allow for future studies of the relationships between adolescents’ risk and benefit perceptions and their electronic cigarette behaviors, as well as support side-by-side comparisons of adolescents’ perceived risk and benefit profiles of electronic cigarettes and combustible cigarettes.

METHODS

Design and Population

This cross sectional pilot study was performed in January 2014 in preparation for a future cohort study. We invited a convenience sample of 138 students who attended a mandatory physical education class at an all-male private high school in the San Francisco Bay Area (USA) to participate. Of those invited, 104 (75%) returned written parental informed consent (if age 17 or younger) or provided signed informed consent on their own behalf (if age 18 or older). An anonymous web-based questionnaire was administered on tablet computers via web-based survey software (Qualtrics, www.qualtrics.com). No identifying personal information was collected. Participants received a \$10 gift card redeemable at a major online retailer.

Measurement

Data were collected regarding participant demographics: age, race (6 categories and open-ended response, later grouped as Asian, white, other/more than one, or don't know/no answer), ethnicity (later grouped as Hispanic/Latino versus non-Hispanic/don't know/other),

parental education (7 categories for mother and father, later dichotomized as 1 parent with a college degree versus no parent with a college degree), and amount of spending money per week (6 levels ranging from none to >\$50). Questions regarding tobacco-related perceptions and behaviors were asked separately for cigarettes and electronic cigarettes. For electronic cigarettes, participants were given a brief description, shown photographs, and asked whether they had ever heard of the product. The description included alternative terminology (eg, “hookah pens” or “vapor pens”) and photographs of earlier and later generation devices (eg, cigarette-resembling disposable devices and reusable devices). Participants who had heard of electronic cigarettes were asked whether they had “ever tried electronic cigarettes, even once or twice.” Those who responded affirmatively were classified as ever-users. Separately, ever-users of either product were asked, “During the past 30 days, on how many days did you use [cigarettes/electronic cigarettes]?” Those responding 1 day were classified as current users.¹⁰ Participants who had never tried, but in the case of electronic cigarettes had heard of the product, were asked, “Do you think you will be using [cigarettes/electronic cigarettes] a year from now?”²⁴ Those who responded “definitely not” were classified as no intention to use, while those responding “probably not,” “probably yes,” or “definitely yes” were grouped as having a possible intention to use.²⁵ To evaluate total tobacco use, analogous questions (grouped in blocks in individually randomized order) were included in the survey for conventional smokeless tobacco (dip or chewing tobacco), snus, dissolvable compressed tobacco, hookah (tobacco waterpipe), and cigars (including little cigars and cigarillos).

Separately for cigarettes and electronic cigarettes, we asked participants to estimate the probability (0%-100%) that 19 specific health- or social-related outcomes would happen to them. Originally developed for measuring cigarette related-perceptions,⁷ these items were posed conditionally on the hypothetical scenario: “Imagine that you just began using [cigarettes/e-cigarettes]. You use [cigarettes/e-cigarettes] 2 to 3 times per day. Sometimes you use alone, and sometimes you use with friends.” The order in which outcomes were displayed was individually randomized. Outcomes included 7 health risks: bad cough, decreased athletic performance, heart attack, lung cancer, mouth cancer, mouth sores, and trouble catching your breath; 7 social/other risks: bad breath, become addicted, brown teeth, get into trouble, harm someone nearby, upset family, and upset friends; and 5 possible benefits: feel more alert, feel more relaxed, fit in more, increased athletic performance, and look cool. Randomly, with equal probability, participants were either provided blank spaces or visual scales with horizontal sliding bars to indicate their responses (Figure 1). Participants assigned to a blank space were much more likely to provide a numeric response ending in zero (79% of responses ended in zero) than those assigned to sliding bars (29% of responses ended in zero). Despite digit preference, the distribution and mean of response values were similar for participants assigned to blank spaces versus those assigned to sliding bars; therefore, results were pooled. Adjusting for item format (boxes versus bars) in statistical models did not lead to meaningful differences in results.

Statistical Analyses

To examine each possible risk and benefit outcome individually, we calculated the mean perceived probability of each item among ever-users and never-users for cigarettes and for

electronic cigarettes. To account for repeated measures within individuals and to adjust for possible confounders, we fitted separate mixed effects linear regression models for the perceived probability of each of the 19 risks or benefits (dependent variable), including terms for product (cigarette or electronic cigarette), ever-use, product X ever-use interaction, and participant demographics. For improved interpretability of adjusted estimates (ie, to return to the original 0% - 100% scale), we calculated marginal adjusted mean probabilities of each risk and benefit.^{26,27}

To analyze the multiple, potentially correlated perceived risk and benefit items simultaneously, we performed principal components analysis (Varimax rotation) to obtain composite variables, following an example previously applied for cigarette-related perceptions.⁸ In analyzing cigarettes and electronic cigarettes separately, there were 2 components: perceived risks (including health risks and social/other risks as a single component) and perceived benefits. Composite scores for perceived risks and benefits were calculated as the mean score for each individual on the 14 risk items and 5 benefit items, respectively, next transformed into quartiles.⁸ For cigarettes and electronic cigarettes separately, we fitted 2 log-linear regression models for the outcomes ever-use and possible intention to use (among never-users), using perceived risk and benefit quartiles as independent variables and adjusting for age, spending money, race, ethnicity, parental education, and item format. The quartiles of composite scores were treated as linear variables, after confirming linear relationships with ever-use and intention to use on the log-probability scale.

In all analyses, multiple imputation (regression model-based method with 10 imputations) was used to replace missing values for covariates: ever-use (N = 2 individuals), intention to use (N = 1), and parental college degree (N = 10). For the principal components analysis, individuals missing 50% of the 19 perception items were excluded (N = 3); however, missing perceived probabilities were multiply imputed for individuals missing <50% of items (N = 8). Non-parametric 95% confidence intervals (CIs) were obtained via bootstrap re-sampling of individuals (1000 iterations). Differences in adjusted means were considered statistically significant if the 95% CI for the difference excluded 0; statistical interaction was considered significant if the 90% CI for the interaction effect excluded 0. Analyses were completed using statistical software (Stata 12.1 and R 3.1.1).

RESULTS

Characteristics and Tobacco Behaviors of Study Population

One hundred four high school male students completed the questionnaire (mean age: 15.3 years; range: 13 to 18). Approximately half were in the ninth grade; the rest were about evenly split among tenth through twelfth grades. The majority had at least one parent with a college degree, and most had more than \$10 available to spend at their discretion each week (Table 1). Forty percent had ever used at least one tobacco product, and 19% had used tobacco in the past 30 days. Familiarity with electronic cigarettes exceeded 90%, and reported ever-use of electronic cigarettes (21%) was approximately equal to reported ever-use of cigarettes (20%; Table 2). Possible intention to use (ie, any response other than “definitely not” regarding use within the next year) was 23% for cigarettes among cigarette

never-users and 32% for electronic cigarettes among electronic cigarette never-users (Table 2).

Perceptions Among Ever-Users and Never-Users of Electronic Cigarettes

For all health risks and all social/other risks, ever-use of electronic cigarettes was associated with lower perceived probabilities that unfavorable outcomes would happen (Figure 2). The difference in risk probability was statistically significant for all but 2 of the outcome items: get into trouble and become addicted (Table 3). In contrast, smaller differences in perceived probabilities were observed for possible benefits when comparing ever-use to never-use of electronic cigarettes. For the majority of items, ever-use was associated with greater perceived probability of benefit, but these differences were not statistically significant (Figure 2; Table 3).

Perceptions for Electronic Cigarettes and Cigarettes

The risk perception items demonstrated comparable patterns for cigarettes and electronic cigarettes. Generally, ever-use was associated with lower perceived probability of each risk and higher perceived probability of each benefit, regardless of whether use referred to cigarettes or electronic cigarettes (Figure 2). However, a small number of items (one risk item and 3 benefit items for cigarettes; one benefit item for electronic cigarettes) deviated from this pattern (Figure 2).

Across all risk items, ever-use was associated with lower perceived risk probability whether concerning combustible cigarettes or electronic cigarettes, but the difference in risk perceptions between ever-users and never-users was greater in reference to electronic cigarettes. In other words, use behavior was more strongly associated with perceived risks for electronic cigarettes than for cigarettes. This statistical interaction between product and ever-use was statistically significant for 12 of the 14 risk items (Table 3). In addition, both among ever-users of each product and among never-users of each product, electronic cigarettes were associated with lower perceived risks than cigarettes, and these differences in risk perceptions between the 2 products were larger and more frequently statistically significant among ever-users than among never-users of each product (Figure 2; Table 3).

Composite Risk and Benefit Scores

For both cigarettes and electronic cigarettes, the composite perceived risk scores and composite perceived benefit scores derived from principal components analysis were associated with tobacco ever-use and with intention to use (Table 4). Although not reaching statistical significance for all associations, the magnitude and direction of associations were comparable for both tobacco products. For both cigarettes and electronic cigarettes, each increasing quartile of perceived risk score was associated with a lower prevalence of ever-use and lower prevalence of possible intention to use. Conversely, for both products, each increasing quartile of perceived benefit score was associated with a greater prevalence of ever-use and greater prevalence of possible intention to use (Table 4). Associations were similar across both products and both behavior measures, but were strongest and only statistically significant regarding ever-use of electronic cigarettes.

DISCUSSION

In this pilot survey, a conditional risk assessment instrument for electronic cigarettes performed similarly as a previously established instrument designed for measuring adolescents' cigarette-related perceptions.⁷ Among both ever-users and never-users, and across the vast majority of potential risk and benefit items included in this instrument, participants rated the probability of unfavorable events as significantly lower with electronic cigarettes than with cigarettes. Furthermore, in this study, ever-users of electronic cigarettes viewed unfavorable outcomes as less probable than did never-users, and this contrast in risk perceptions between ever-users and never-users was consistently greater for electronic cigarettes than for combustible cigarettes. When considering potentially favorable outcomes, differences in perceptions were not as large as perceived differences in risks. Yet, after combining the individual benefit items into a composite measure, perceived benefit scores were positively and significantly associated with electronic cigarette use. This mirrored results for composite perceived risk, which was inversely and significantly associated with electronic cigarette use.

Perceptions, including potential misconceptions, regarding health effects of electronic cigarettes could contribute to adolescents' use and could carry implications for possible anti-tobacco messages. Accurate measurement of adolescents' perceptions of risks and benefits of specific tobacco products can provide prevention programs targeting adolescents with credible and age-appropriate information.²⁸ In particular, if individuals compartmentalize new and alternative products as distinct entities from combustible cigarettes, associated with different social and health consequences, product-specific interventions may be necessary to prevent use and/or encourage cessation. Among young adults, for example, negative views of the tobacco industry were associated with less cigarette smoking, but not with less hookah use, suggesting that some existing anti-tobacco efforts that target cigarette smoking might not be effective at reducing use of other tobacco products.²⁹

Several recent reports have examined electronic cigarette-related risk perceptions, although none to date have performed conditional risk assessment in an adolescent population. About one-third of respondents in the 2012 National Youth Tobacco Survey (NYTS) reported that they viewed electronic cigarettes as less harmful than cigarettes.^{19,20} In the NYTS, ever-users of electronic cigarettes were more likely to rate electronic cigarettes as less harmful than cigarettes than were never-users of electronic cigarettes.¹⁹ Notably, 50% of respondents to that survey stated they had never heard of electronic cigarettes or did not know enough to answer.¹⁹ Consisting of all-male students at a private school, our convenience sample differed importantly from nationally representative NYTS. Our study was also conducted more recently, and familiarity with electronic cigarette was widespread among our sample. Among adults who completed an online survey that featured conditional risk assessment, cigarette smokers perceived that regular use of electronic cigarettes would be associated with lower risk of lung cancer, heart disease, and oral cancer compared to regular cigarette smoking.³⁰ As with our instrument, the latter survey advantageously assessed harm in relation to specific outcomes and conditional upon a stated tobacco behavior of the respondent.³⁰ The online adult survey and our instrument both assessed electronic cigarettes

and cigarettes in separate questions (indirect comparison), which could reveal underlying differences in beliefs more readily.²³

In our sample, for both cigarettes and electronic cigarettes, the associations between future use intentions and the composite scales of perceived risks and benefits were similar in magnitude and direction as the associations between perceptions and ever-use; however, the associations with intentions did not reach statistical significance. This lack of statistical significance could be attributed to the size of the analytic sample, which was exploratory in nature and designed to assess feasibility of the methods. It remains necessary to confirm any quantitative findings in larger, more representative samples. Although not statistically significant, the associations observed were coherent and consistent with previous studies of adolescent tobacco-related perceptions.^{7,18} Also of note, our principal components analysis identified 2 main components (ie, risks and possible benefits), rather than the 3 components (ie, long-term risks, short-term risks, and possible benefits) that were identified in an earlier study of cigarettes.⁸ However, the composition of the populations and variation in the set of specific health and social outcome items probed in each study could have contributed to the difference in item grouping.

The modified conditional risk assessment instrument applied in this study could be readily adapted for additional tobacco products, such as snus or hookah. The incorporation of a visual scale eliminated a need for participants to type responses, reduced digit preference for probabilities ending in zero, and did not appear to present comprehension issues in this population. The instrument format closely followed that of a previously established instrument,⁷ demonstrated internal consistency across individual risk and benefit outcomes, and was associated with electronic cigarette behaviors in the hypothesized directions.

Ever-use of cigarettes and electronic cigarettes were the main behavioral outcomes assessed in this study, rather than current use (past 30-days), which was less common in our sample. Ever-use is a necessary precedent to regular tobacco use, and adolescents can develop nicotine dependence, even if using tobacco intermittently.^{31,32} In several recent studies of electronic cigarette use among adolescents, ever-use was a primary metric for defining behavior.^{14,33,34} Further research is needed to confirm whether the observed patterns in tobacco-related perceptions and ever-use observed in this study also hold for current use.

As a limitation, it was not possible from cross-sectional data to determine the extent to which preconceived perceptions were drivers of tobacco-related behaviors, as opposed to adolescents' actual experiences with tobacco products shaping their risk and benefit perceptions. We are currently enrolling adolescent participants in a 4-year cohort study of multiple schools over a wider geographic area that will, in part, assess whether the initial associations identified in this study persist longitudinally and hold in a larger sample with multiple waves. Additionally, this study relied on data collected from a convenience sample at a single all-male high school; therefore the results are not necessarily representative of adolescents generally. Sex and socioeconomic position (SEP) are key factors related to tobacco use among adolescents^{4,10}; thus, our findings must be corroborated in a more generalizable population that includes both male and female participants and a broader range of SEP. Systematically collected samples and analyses that account for possible clustering

by school or classroom are needed. Finally, while the study sample had sufficient power to detect numerous statistically significant differences, it is plausible that potentially meaningful associations, such as between perceived benefits and reported behaviors, did not reach statistical significance only due to sample size considerations. Beyond these limitations, the ability of the instrument to identify distinct patterns in adolescents' risk and benefit profiles related to cigarettes and electronic cigarettes supports application in future research, with potential expansion for use regarding additional alternative tobacco products, including those yet to enter the market.

In this study, we found that a modified conditional risk assessment instrument could be used to characterize the profile of adolescents' perceived risks and benefits related to electronic cigarettes, in a similar manner as has been done to characterize adolescents' perceptions of cigarette use.⁷ Specifically, we observed wider differences in perceived risks between ever-users and never-users of electronic cigarettes than between cigarette ever-users and never-users. This finding raises the possibility that, in the present environment of still-accumulating scientific evidence and unrestricted commercial marketing, perceptions could be even more strongly associated with behavior for electronic cigarettes than for cigarettes. Given the robust connection between adolescents' risk and benefit perceptions and their behaviors related to cigarette smoking,⁷⁻⁹ longitudinal studies in large, representative samples are merited to confirm this pattern for non-cigarette tobacco products. Such studies would offer greater quantitative certainty regarding the magnitude of associations than was possible from this relatively small pilot study.

The modified instrument developed in this study offers a potentially flexible measurement tool for assessing non-cigarette tobacco-related perceptions, which could help these future studies to expand our understanding of how adolescents make behavioral decisions regarding electronic cigarettes and other alternative tobacco products. Such research has potential implications for identifying use-susceptible individuals and for measuring the impact of tobacco marketing. Greater understanding would aid the development of health promotion messages and increase the effectiveness of anti-tobacco prevention and intervention programs.

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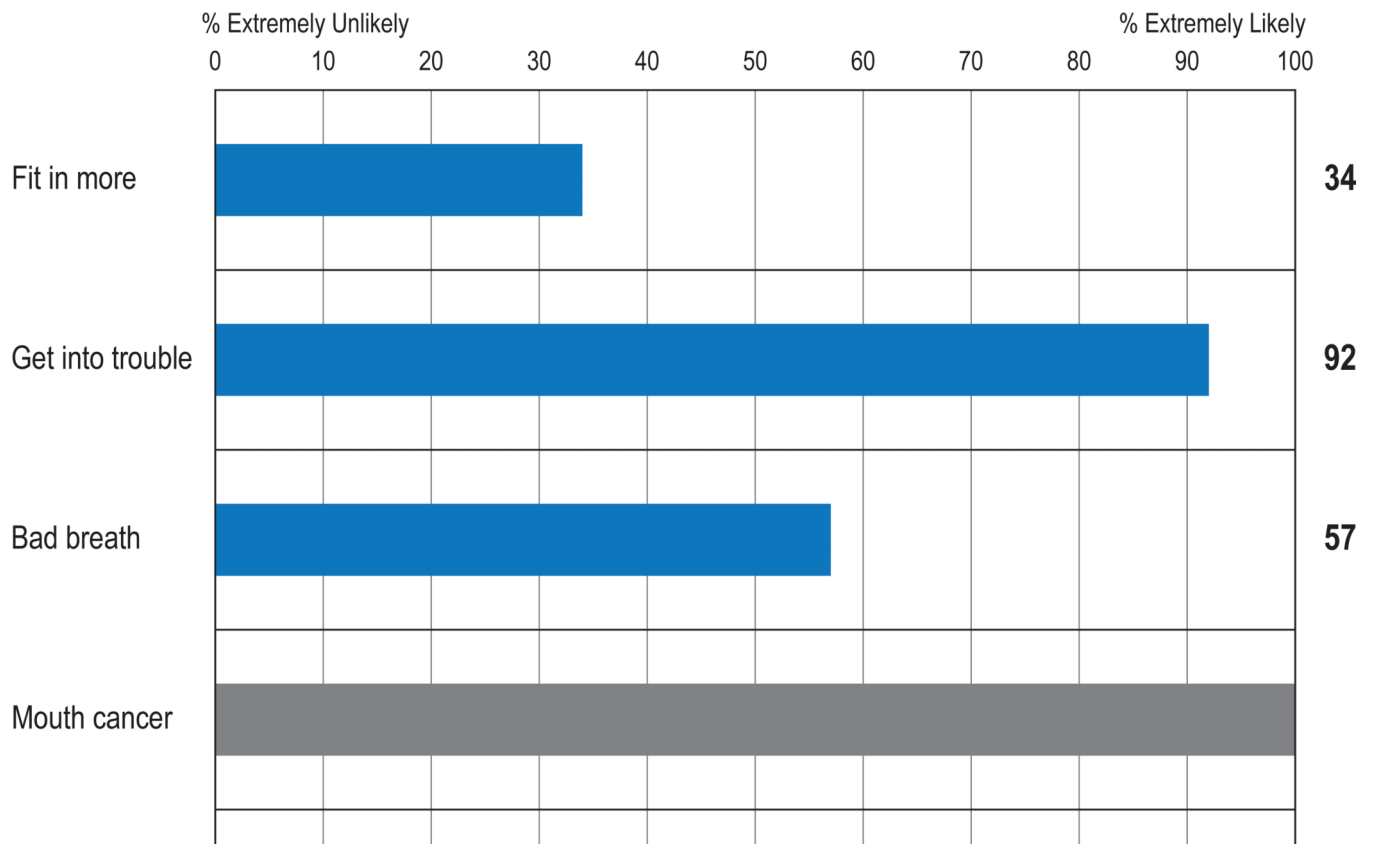


Figure 1. Example Questionnaire Item with Horizontal Sliding Bars

Participants were randomly assigned, with equal probability, to either blank spaces or sliding bars (depicted above) to indicate their perceived probability, from 0% to 100%, that specific outcomes would happen to them, under the hypothetical condition that they had just begun using cigarettes or electronic cigarettes. The sliding bar was manipulated by touching the screen on tablet computers running survey software (Qualtrics, www.qualtrics.com). The figure above shows the first 4 of a list of specific outcome items. In the figure, the blue bars have been manipulated to indicate a response, while the gray bar has not yet been moved. All participants were shown the same outcome items but in individually randomized order.

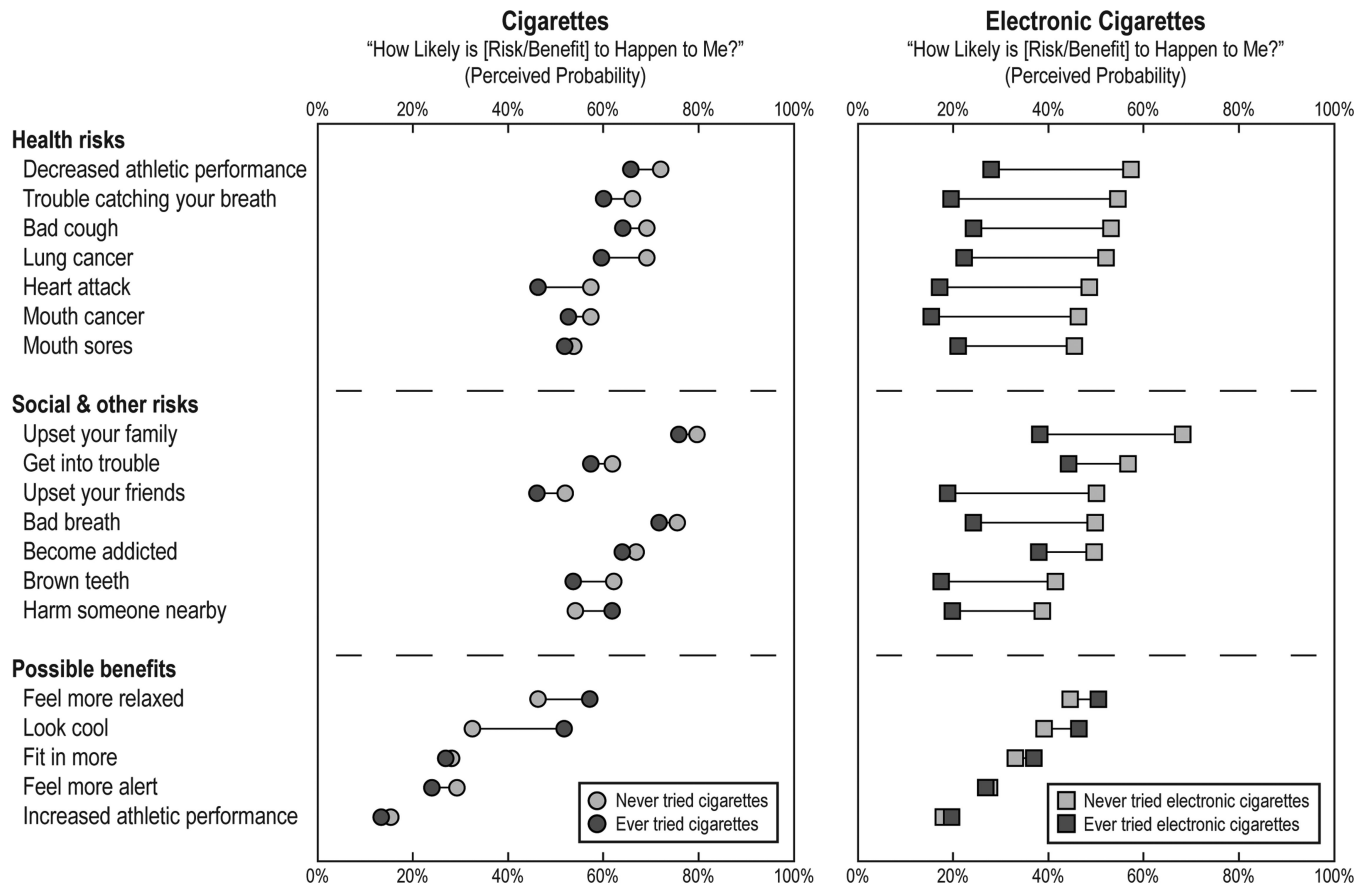


Figure 2. Adjusted Mean Perceived Risks and Benefits for Use of Cigarettes and Electronic Cigarettes, Among Ever-Users and Never-Users of Each Product

The figure shows adjusted mean perceived probabilities for each of 19 possible outcomes among male high school students. Probabilities indicate the reported likelihood with which respondents believed each outcome would happen to them if they were to use cigarettes (circles) or electronic cigarettes (squares). For each product, responses are separated for ever-users of each product (dark gray) and never-users (light gray).

Table 1

Participant Characteristics, Male Urban High School Students (N = 104)

Characteristic	
Age in years, mean (SD)	15.3 (1.3)
Grade in school, n (%)	
9th	51 (50)
10th	19 (18)
11th	19 (18)
12th	14 (14)
Self-identified race/ethnicity, n (%)	
Asian, non-Hispanic	12 (12)
Hispanic	35 (34)
white, non-Hispanic	23 (22)
other/more than one	25 (24)
no answer/don't know	9 (9)
1 parent with college degree, n (%)	
Yes	60 (64)
No	34 (36)
Weekly spending money, n (%)	
\$0	11 (11)
\$1 - \$5	8 (8)
\$6 - \$10	9 (9)
\$11 - \$20	32 (31)
\$21 - \$50	15 (14)
more than \$50	29 (28)

Sample size varies for some characteristics due to missing data

SD = standard deviation

Table 2

Tobacco-Related Behaviors, Male Urban High School Students (N = 104)

	Heard of Product, n (%)	Ever-Use (lifetime), n (%)	Current Use (past 30 days), n (%)	Intention to Use ^a (among never-users), n (%)
Cigarettes	^b	21 (20)	4 (4)	19 (23)
Electronic cigarettes	95 (91)	22 (21)	10 (10)	26 (32)
Any tobacco ^c	-	41 (40)	19 (19)	-

^a Any responses other than “definitely not” regarding future use

^b Familiarity with cigarettes was assumed

^c Includes: cigarettes, electronic cigarettes, cigars, cigarillos, little cigars, hookah, snus, dissolvable compressed tobacco, and conventional smokeless tobacco (dip or chewing tobacco)

Table 3

Adjusted Mean Perceived Risks and Benefits for Use of Cigarettes and Electronic Cigarettes, Among Ever-Users and Never-Users of Each Product.

Part A. Health risks				
	Perceived probability of outcome^a	Difference versus cigarettes	Difference versus never-users	Product X ever-use interaction^b
Decreased athletic performance				
Cigarettes, never-users	72.0	reference	reference	
Cigarettes, ever-users	66.1	reference	-5.9	
Electronic cigarettes, never-users	57.3	-14.7*	reference	
Electronic cigarettes, ever-users	28.0	-38.1*	-29.3*	-23.4 [‡]
Trouble catching your breath				
Cigarettes, never-users	66.2	reference	reference	
Cigarettes, ever-users	59.6	reference	-6.6	
Electronic cigarettes, never-users	54.7	-11.5*	reference	
Electronic cigarettes, ever-users	19.2	-40.4*	-35.5*	-28.9 [‡]
Bad cough				
Cigarettes, never-users	69.3	reference	reference	
Cigarettes, ever-users	63.7	reference	-5.6	
Electronic cigarettes, never-users	53.2	-16.0*	reference	
Electronic cigarettes, ever-users	23.9	-39.8*	-29.3*	-23.7 [‡]
Lung cancer				
Cigarettes, never-users	69.4	reference	reference	
Cigarettes, ever-users	58.9	reference	-10.5	
Electronic cigarettes, never-users	52.2	-17.1*	reference	
Electronic cigarettes, ever-users	21.8	-37.1*	-30.5*	-20.0 [‡]
Heart attack				
Cigarettes, never-users	57.5	reference	reference	
Cigarettes, ever-users	45.7	reference	-11.8	
Electronic cigarettes, never-users	48.7	-8.9*	reference	
Electronic cigarettes, ever-users	16.8	-28.9*	-31.9*	-20.0 [‡]
Mouth cancer				
Cigarettes, never-users	57.5	reference	reference	
Cigarettes, ever-users	52.2	reference	-5.3	
Electronic cigarettes, never-users	46.4	-11.1*	reference	
Electronic cigarettes, ever-users	15.0	-37.2*	-31.4*	-26.1 [‡]
Mouth sores				

Part A. Health risks				
	Perceived probability of outcome ^a	Difference versus cigarettes	Difference versus never-users	Product X ever-use interaction ^b
Cigarettes, never-users	53.8	reference	reference	
Cigarettes, ever-users	51.4	reference	-2.4	
Electronic cigarettes, never-users	45.5	-8.3	reference	
Electronic cigarettes, ever-users	20.8	-30.6*	-24.7*	-22.3 [‡]
Part B. Social and other risks				
	Perceived probability of outcome ^a	Difference versus cigarettes	Difference versus never-users	Product X ever-use interaction ^b
Upset your family				
Cigarettes, never-users	79.6	reference	reference	
Cigarettes, ever-users	76.0	reference	-3.6	
Electronic cigarettes, never-users	68.2	-11.4*	reference	
Electronic cigarettes, ever-users	38.2	-37.8*	-30.0*	-26.4 [‡]
Get into trouble				
Cigarettes, never-users	62.0	reference	reference	
Cigarettes, ever-users	57.2	reference	-4.8	
Electronic cigarettes, never-users	56.8	-5.2	reference	
Electronic cigarettes, ever-users	44.0	-13.2	-12.7	-8.0
Upset your friends				
Cigarettes, never-users	52.2	reference	reference	
Cigarettes, ever-users	45.5	reference	-6.6	
Electronic cigarettes, never-users	50.2	-2.0	reference	
Electronic cigarettes, ever-users	18.4	-27.1*	-31.8*	-25.1 [‡]
Bad breath				
Cigarettes, never-users	75.7	reference	reference	
Cigarettes, ever-users	71.1	reference	-4.6	
Electronic cigarettes, never-users	49.9	-25.8*	reference	
Electronic cigarettes, ever-users	23.8	-47.3*	-26.1*	-21.5 [‡]
Become addicted				
Cigarettes, never-users	67.0	reference	reference	
Cigarettes, ever-users	63.5	reference	-3.5	
Electronic cigarettes, never-users	49.7	-17.3*	reference	
Electronic cigarettes, ever-users	37.6	-25.9*	-12.0	-8.6
Brown teeth				
Cigarettes, never-users	62.3	reference	reference	
Cigarettes, ever-users	53.4	reference	-8.9	

Part B. Social and other risks				
	Perceived probability of outcome^a	Difference versus cigarettes	Difference versus never-users	Product X ever-use interaction^b
Electronic cigarettes, never-users	41.5	-20.8*	reference	
Electronic cigarettes, ever-users	17.2	-36.2*	-24.4*	-15.4 [‡]
Harm someone nearby				
Cigarettes, never-users	54.1	reference	reference	
Cigarettes, ever-users	62.0	reference	7.9	
Electronic cigarettes, never-users	38.7	-15.4*	reference	
Electronic cigarettes, ever-users	19.7	-42.2*	-19.0*	-26.9 [‡]

Part C. Possible benefits				
	Perceived probability of outcome^a	Difference versus cigarettes	Difference versus never-users	Product X ever-use interaction^b
Feel more relaxed				
Cigarettes, never-users	46.2	reference	reference	
Cigarettes, ever-users	56.9	reference	10.6	
Electronic cigarettes, never-users	44.6	-1.7	reference	
Electronic cigarettes, ever-users	50.2	-6.7	5.6	-5.0
Look cool				
Cigarettes, never-users	32.7	reference	reference	
Cigarettes, ever-users	50.9	reference	18.3*	
Electronic cigarettes, never-users	39.2	6.6	reference	
Electronic cigarettes, ever-users	45.8	-5.1	6.5	-11.7
Fit in more				
Cigarettes, never-users	28.4	reference	reference	
Cigarettes, ever-users	26.1	reference	-2.3	
Electronic cigarettes, never-users	33.2	4.8	reference	
Electronic cigarettes, ever-users	36.4	10.4	3.3	5.5
Feel more alert				
Cigarettes, never-users	29.4	reference	reference	
Cigarettes, ever-users	23.5	reference	-5.8	
Electronic cigarettes, never-users	27.7	-1.6	reference	
Electronic cigarettes, ever-users	26.4	2.9	-1.3	4.6
Increased athletic performance				
Cigarettes, never-users	15.5	reference	reference	
Cigarettes, ever-users	12.7	reference	-2.8	
Electronic cigarettes, never-users	18.0	2.5	reference	
Electronic cigarettes, ever-users	19.2	6.5	1.2	4.0

^a Adjusted for age, race/ethnicity, parental education, spending money, and item format

^b Difference in magnitude of ever/never use association for cigarettes versus electronic cigarettes

* Statistically significant from reference value (p = 0.05)

[‡] Statistically significant interaction (p = 0.10)

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Table 4

Associations of Perceived Risks and Benefits with Product Ever-Use and Intention to Use Cigarettes and Electronic Cigarettes

	Ever-Use		Possible Intention to Use ^a	
	Cigarettes	Electronic Cigarettes	Cigarettes	Electronic Cigarettes
	PR (95% CI)	PR (95% CI)	PR (95% CI)	PR (95% CI)
Perceived Risks ^b				
Unadjusted	0.76 (0.49, 1.06)	0.34 (0.15, 0.57)	0.78 (0.55, 1.21)	0.75 (0.51, 1.01)
Adjusted ^c	0.81 (0.47, 1.15)	0.30 (0.08, 0.58)	0.90 (0.54, 1.73)	0.74 (0.52, 1.06)
Perceived Benefits ^d				
Unadjusted	1.21 (0.91, 1.91)	1.22 (0.99, 1.72)	1.39 (0.96, 2.15)	1.27 (0.95, 1.73)
Adjusted ^c	1.33 (0.97, 2.41)	1.69 (1.10, 3.56)	1.34 (0.85, 3.15)	1.24 (0.84, 1.90)

Abbreviations: CI = confidence interval; PR = prevalence ratio

^a Among never-users of the product

^b Quartile of mean score over 14 tobacco-related negative health or social outcomes

^c Adjusted for age, race/ethnicity, parental education, spending money, and item format

^d Quartile of mean score over 5 tobacco-related positive health or social outcomes