Perceptions of the Harm and Addictiveness of Conventional Cigarette Smoking Among Adolescent E-Cigarette Users

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ABSTRACT

Purpose: Though existing evidence indicates that e-cigarette use is a risk factor for cigarette smoking initiation, mechanisms of this association are not yet known. E-cigarette users perceive e-cigarette use to be less harmful relative to conventional cigarettes, but their absolute perceptions of addictiveness of conventional cigarette smoking are unknown. This study examines how e-cigarette users compare with nonusers (non–e-cigarette users/nonconventional cigarette smokers), conventional cigarette smokers, and dual users on perceptions of harm and the addictiveness of conventional cigarette smoking and on other known predictors of cigarette smoking such as peer smoking, influence of antismoking ads, and risk-taking propensity.

Methods: National samples of 8th- and 10th-grade students from 2014 and 2015 (N = 14,151) were obtained from the Monitoring the Future Study. Multivariate logistic regression models were used to examine relationships between adolescent smoking status and perceptions of harm and the addictiveness of conventional cigarette smoking while controlling for potential confounders.

Results: E-cigarette users had lower perceptions of the addictiveness of conventional cigarette smoking compared with nonusers but higher than cigarette smokers and dual users. E-cigarette users reported lower influence by antismoking ads, more conventional cigarette-smoking peers, and greater risk-taking propensity than nonusers. E-cigarette users and cigarette smokers did not differ in their perceived harm of conventional cigarette smoking or in their risk-taking propensity.

Conclusions: E-cigarette users’ attitudes and perceptions regarding conventional cigarette smoking may leave them vulnerable to becoming conventional cigarette smokers. Future studies should explore the prospective relationship between smoking-related perceptions of conventional cigarette smoking among e-cigarette users and the onset of cigarette smoking.

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IMPLICATIONS AND CONTRIBUTION

This study reveals attitudes and perceptions among e-cigarette users that may leave them vulnerable to cigarette smoking: lowered perceptions of cigarettes’ addictiveness, less influence by antismoking ads, and more peers who smoke compared with nonusers. Findings suggest adolescent smoking prevention campaigns should emphasize the addictiveness of all forms of tobacco use.

Nicotine addiction is an established outcome of conventional cigarette smoking in adolescents [1,2] and may occur even before the onset of daily smoking [3,4]. It underlies the progression from cigarette experimentation to sustained smoking, which precipitates smoking-related diseases [5]. Adolescents may be vulnerable to nicotine addiction because of ongoing brain

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development [6] and greater brain sensitivity to nicotine [7]. Nicotine delivered to the brain can impair working memory, attention, executive functioning, and impulse control [8–10]. Further, adolescents’ smoking-related perceptions may influence their smoking behavior, increasing the risk of nicotine addiction. For example, adolescent smokers have poor insight regarding their risk for nicotine addiction and difficulty quitting smoking once addicted [11–16]. This suggests the need for research to inform educational interventions that heighten adolescents’ perceptions of the addictive potential of all tobacco products including e-cigarettes.

While the prevalence of conventional cigarette smoking has declined over the years, the prevalence of electronic cigarette (e-cigarette) use continues to increase and has surpassed that of conventional cigarette smoking among adolescents [17,18]. E-cigarettes have become a major source of nicotine to adolescents. The reported use of e-cigarettes in the past 30 days increased from 6% in 2011 to 5.3% in 2015 among middle school students and from 1.5% in 2011 to 16% in 2015 among high school students [17].

Prior to 2016, the U.S. Food and Drug Administration had no regulatory authority over e-cigarettes, and the manufacturing, labeling, distribution, and marketing of e-cigarettes were largely unregulated [19]. Although research on the health risks of e-cigarettes is still ongoing, e-cigarettes that contain nicotine have addiction potential because they deliver nicotine to the blood [20,21]. In addition, recent studies have demonstrated longitudinal associations between e-cigarette use and conventional cigarette smoking in adolescents, even among the least susceptible, who had no intentions to smoke conventional cigarettes at baseline [22,23]. Thus, e-cigarette use may facilitate the initiation of conventional cigarette smoking among adolescents, potentially resulting in nicotine addiction [22–25].

Although existing evidence indicates that e-cigarette use is a risk factor for cigarette smoking initiation [22–25], the mechanisms of this association are not yet known. Perceptions of harm and the addictiveness of conventional cigarette smoking are important predictors of adolescent smoking behavior, which may differ depending on smoking status and may influence the transition between tobacco products. Previous comparative studies on adolescents’ perceptions of harm and the addictiveness of cigarette smoking have generated two major findings. First, conventional cigarette smokers acknowledge the physical harm associated with their behavior but underestimate the risk of nicotine addiction and believe they are less likely to become addicted to nicotine in comparison with the average smoker [11,13,26,27]. This has been referred to as optimistic bias—a perception of one’s risk as less than that of others [28]. Second, in comparative perceptions of harm and the addictiveness of one tobacco product to another, adolescents perceive conventional cigarettes to be more harmful and addictive than e-cigarettes [29–34]. Adolescent e-cigarette users, dual users, and nonusers believe e-cigarettes are less harmful than conventional cigarettes [29–35]. Similarly, adolescent conventional cigarette smokers with a history of e-cigarette use are more likely than those with no such history to believe e-cigarettes are less harmful than conventional cigarettes [29].

While the extant literature has generated informative data on adolescents’ perceptions of the relative risks of nicotine addiction, studies that specifically examine adolescents’ absolute risk perceptions of the addictiveness of conventional cigarette smoking are lacking. In contrast to relative comparisons of one tobacco product to another or a comparison of one’s own addiction risk to others’, absolute risk directly captures adolescents’ self-perceptions of addiction and health risks of specific tobacco products. Research on e-cigarette users’ absolute risk perceptions of the addictiveness of conventional cigarette smoking is limited. It is important to examine the perceptions that e-cigarette users hold regarding the addiction risk of conventional cigarette smoking because it may provide insights into why they use e-cigarettes and whether and how they are vulnerable to initiating conventional cigarette smoking. In addition, a comparison of perceptions of the risk of conventional cigarette smoking between e-cigarette–only users and dual users (smokers of both conventional cigarettes and e-cigarettes) is warranted. Previous research has documented significant differences between e-cigarette users and dual users in socio-cognitive protective and risk factors, problem behavior risk factors, and use of other substances, indicating that the etiology of nicotine addiction in dual users may differ from that of exclusive e-cigarette or cigarette smokers [35]. As the popularity of e-cigarettes continues to rise, it is important to understand how e-cigarette users compare with nonusers, conventional cigarette smokers, and dual users on absolute perceptions of the addiction risk of conventional cigarette smoking, and on other known predictors of conventional cigarette smoking such as peer smoking, the influence of antismoking ads, and risk-taking propensity. Such understanding will help to better characterize the adolescent e-cigarette user population and design effective campaigns to communicate potential harms and the addictiveness of e-cigarettes.

In the current study, we examine how e-cigarette users compare with nonusers, conventional cigarette smokers, and dual users on smoking-related perceptions in a national sample of 8th- and 10th-grade students. Specifically, we examine absolute risk perceptions of the addictiveness of conventional cigarette smoking, perceived harm of conventional cigarette smoking, and perceived harm of e-cigarette use. Our study extends the literature by describing e-cigarette users’ absolute risk perceptions of the addictiveness and harm of conventional cigarette smoking while accounting for other factors such as sociodemographic variables, peer smoking, perceived influence of antismoking ads, and risk-taking propensity.

Methods

Study participants

National samples of 8th- and 10th-grade students from 2014 to 2015 (N = 14,151) were obtained from the Monitoring the Future Study, an annual national cross-sectional survey on adolescent substance use and related behaviors [36]. Participants were included in the current sample if they were classified as white, black, or Hispanic (all other races/ethnicities are combined in the data and therefore uninterpretable) and had nonmissing data on both outcome measures, and e-cigarette and cigarette use. Data were accessed through the Inter-University Consortium for Political and Social Research (www.icpsr.umich.edu). This study was exempt from institutional review board oversight.

Measures

Conventional cigarette smoking was measured via one item: “How frequently have you smoked cigarettes during the past 30
days?" Response was on a seven-point scale ranging from "not at all" to "two packs or more per day" but was dichotomized into any use (1) versus no use (0) for this study.

Similarly, e-cigarette smoking was measured via one item: "During the last 30 days, on how many days (if any) have you used electronic cigarettes (e-cigarettes)?" Response was on a six-point scale ranging from "none" to "20–30 days" but was dichotomized into any use (1) versus no use (0) for this study.

Absolute perceptions of the addiction risk of conventional cigarette smoking (subsequently referred to as perceived addictiveness of conventional cigarette smoking) were measured using two items: "How much do you agree or disagree with the following statements?" "I could smoke a pack a day for a year or more and still be able to quit if I wanted to" and "At my age, smoking is not too dangerous because you can always quit later." Responses for each measure were on a five-point scale: "disagree" (1), "mostly disagree" (2), "neither" (3), "mostly agree" (4), and "agree" (5). These items are similar to those used in other studies regarding addiction perceptions among adolescents [11–13,26]. The two items were reverse-coded and averaged for analysis to avoid multicollinearity because they were significantly positively correlated ($r = .33$, $p < .001$). Higher scores reflected higher perceived addictiveness.

Perceived harm of cigarette smoking was measured via one item: "How much do you think people risk harming themselves (physically or in other ways), if they smoke one or more packs of cigarettes per day?" Responses were on a four-point scale ranging from "no risk" (1) to "great risk (4)."

Perceived harm of e-cigarette use was similarly measured with cigarettes substituted with e-cigarettes. "How much do you think people risk harming themselves (physically or in other ways), if they use electronic cigarettes (e-cigarettes) regularly?" Responses were on a four-point scale ranging from "no risk" (1) to "great risk" (4).

Covariates included perceived influence of antismoking advertisements, peer smoking, risk-taking propensity, class grade (8th or 10th), race/ethnicity, and parent education level. Perceived influence of antismoking advertisements was measured via one item: "To what extent do you think such ads (antismoking commercials or 'spots' that are intended to discourage cigarette smoking) on TV, radio, billboards or in magazines and newspapers have made you less favorable toward smoking cigarettes?" Responses were on a five-point scale ranging from "not at all (1)" to "to a very great extent (5)."

Peer smoking was measured via one item: "How many of your friends would you estimate smoke cigarettes?" Responses were on a five-point scale ranging from "none" (1) to "all" (5).

Risk-taking propensity was measured by obtaining the average of two items: "I get a real kick out of doing things that are a little dangerous" and "I like to test myself every now and then by doing something a little risky." Each of the two items had responses on a five-point scale ranging from "disagree" (1) to "agree" (5).

Race/ethnicity was categorized into (non-Hispanic) white, Hispanic, and (non-Hispanic) black. Parent education level, selected as an indicator of socioeconomic status, was measured with a six-point scale ranging from "completing grade school or less" to "graduate or professional school after college." The average of both parent education levels (single parent's education level was used for students with single parents) was determined.

### Table 1

<table>
<thead>
<tr>
<th>Sex</th>
<th>%</th>
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<tbody>
<tr>
<td>Male</td>
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<tr>
<td>Female</td>
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<tr>
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<tr>
<td>Tenth</td>
<td>51.5</td>
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<td>Smoking status</td>
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<tr>
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<tr>
<td>Cigarettes smokers</td>
<td>2.1</td>
</tr>
<tr>
<td>Dual users</td>
<td>3.3</td>
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<td>Nonusers</td>
<td>85.5</td>
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</tbody>
</table>

### Data analysis

Adolescents were classified into one of four smoking status groups: nonusers (had not smoked cigarettes or used e-cigarettes in the past 30 days); conventional cigarette smokers (smoked only cigarettes in the past 30 days); e-cigarette users (used only e-cigarettes in the past 30 days), and dual users (smoked conventional cigarettes and used e-cigarettes in the past 30 days).

Independent samples t-tests were used to test mean differences in smoking-related perceptions across the four smoking groups. Multivariate logistic regression was used to examine the relationships between perceptions of addiction and harm of conventional cigarette smoking, perceived harm of e-cigarette use, perceived influence of antismoking ads, and adolescent smoking status while controlling for risk-taking propensity, peer smoking, and sociodemographic variables. Three models were tested, such that for each model, e-cigarette users were compared with a referent smoking status; (1) e-cigarette users versus nonusers, (2) e-cigarette users versus conventional cigarette smokers, and (3) e-cigarette users versus dual users. Univariate pairwise comparisons were conducted using SPSS Complex samples, version 24 (IBM Corp, Armonk, NY), and multivariate analysis was conducted using Mplus, version 7 (Muthén & Muthén, Los Angeles, CA) [37]. Full information maximum likelihood was used to account for missing data on independent variables. MTF sampling weights were applied in all analyses [36].

### Results

85.5% of participants were nonusers, 9.1% were e-cigarette users, 3.3% were dual users, and 2.1% were cigarette smokers. Descriptive statistics are summarized in Table 1.

Smoking-related perceptions differed by adolescent smoking status in univariate comparisons across groups (Table 2). The four smoking groups differed significantly in perceived addictiveness and perceived harm of conventional cigarette smoking, with scores highest among nonusers, intermediate among e-cigarette users, and least among conventional cigarette smokers and dual users. Also, e-cigarette users differed significantly from nonusers and conventional cigarette smokers on perceived harm of e-cigarette use, with nonusers scoring highest, conventional cigarette smokers and dual users intermediate, and e-cigarette users least.

Results of the multivariate logistic regressions are summarized in Table 3. Compared with nonusers, e-cigarette users had
lower perceived addictiveness of conventional cigarette smoking and lower perceived harm of e-cigarette use (Model 1). E-cigarette users also reported less influence by antismoking ads, higher risk-taking propensity, and more cigarette-smoking friends than nonusers.

Compared with conventional cigarette smokers, e-cigarette smokers had higher perceived addictiveness of conventional cigarette smoking and lower perceived harm of e-cigarette use (Model 2). E-cigarette users reported they were more influenced by antismoking ads and had fewer cigarette-smoking friends than cigarette smokers. Notably, e-cigarette users did not significantly differ from cigarette smokers with regard to perceived harm of conventional cigarette smoking or risk-taking propensity, both known risk factors for conventional cigarette smoking.

Compared with dual users, e-cigarette users reported higher perceived addictiveness of conventional cigarette smoking and higher perceived harm of conventional cigarette smoking. E-cigarette users also reported more influence by antismoking ads and fewer cigarette-smoking friends than dual users. E-cigarette users did not differ from dual users in their perceptions of the harm associated with e-cigarette use.

Discussion

The current study revealed systematic differences in e-cigarette users’ perceptions of addiction and harm of conventional cigarette smoking compared with those of nonusers, conventional cigarette smokers, and dual users. Differences in e-cigarette users’ attitudes and perceptions regarding conventional cigarette smoking (compared with those of nonusers) and similarities to conventional cigarette smokers may leave them vulnerable to becoming conventional cigarette smokers or dual users in the future, potentially increasing their risk for nicotine addiction.

Compared with nonusers, e-cigarette users endorsed a number of attitudes, perceptions, and characteristics that are risk factors for cigarette smoking. First, they had lower perceptions of the addictiveness of conventional cigarette smoking, including greater optimism about their ability to quit conventional cigarette smoking in the future. Previous comparative studies have shown that adolescents generally believe conventional cigarettes smoking is more harmful and addictive than e-cigarette use [29–34]. The current study extends this literature by examining e-cigarette users’ absolute risk perceptions of the addictiveness of conventional cigarette smoking without comparing it to e-cigarette use. Our results suggest e-cigarette users’ perception of the addictiveness of conventional cigarette smoking is weaker than that of nonusers. Second, e-cigarette users had higher levels of risk propensity and more peers who smoke cigarettes, both robust risk factors for cigarette smoking [38,39]. Finally, compared with nonusers, e-cigarette users reported less influence by antismoking ads. Nonresponsivity to antismoking ads is another known risk factor for conventional cigarette smoking [40] and may be an avenue by which e-cigarette smokers are vulnerable to becoming conventional cigarette smokers.

E-cigarette users also differed from cigarette smokers and dual users on several key variables. On several variables known to be risk factors for conventional cigarette smoking, e-cigarette users appeared relatively at low risk. E-cigarette users had higher addiction perceptions of conventional cigarette smoking, indicating less optimism about their ability to quit conventional cigarette smoking in the future, compared with both cigarette smokers and dual users. E-cigarette users perceived conventional cigarette smoking to be more harmful than dual users did. They also reported that they had been more influenced by antismoking ads than both cigarette smokers and dual users.

However, on several other known risk factors for conventional cigarette smoking, e-cigarette users were comparable with or worse than cigarette smokers and/or dual users. E-cigarette users perceived e-cigarettes as less harmful than did cigarette smokers. Their perceptions of the harm of conventional cigarette smoking did not differ from those of cigarette smokers. E-cigarette users also had comparable levels of risk-taking propensity to cigarette smokers and dual users, which may put them at further risk for later cigarette smoking.

In summary, our results yield a profile of e-cigarette users that shows they are quite distinguishable from nonusers on an array of risk factors for conventional cigarette smoking. While they differ from cigarette smokers and dual users in some positive regard, e-cigarette users are overall more similar to cigarette smokers and dual users with regard to their perceived addictiveness and harm of smoking than they are to nonusers. These perceptions may put them at risk for future conventional cigarette smoking.

Past research has shown e-cigarette smokers to be at heightened risk for later cigarette smoking [22–25]. Our study adds to this literature by revealing perceptions that may make adolescent e-cigarette users vulnerable to initiating conventional cigarette smoking. Specifically, we found that optimism regarding quitting smoking in the future, previously demonstrated among adolescent cigarette smokers, also exists among
<table>
<thead>
<tr>
<th></th>
<th>Model 1: E-cigarette users versus nonusers</th>
<th>Model 2: E-cigarette users versus cigarette smokers</th>
<th>Model 3: E-cigarette users versus dual users</th>
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<tbody>
<tr>
<td></td>
<td>B (SE) OR 95% CI</td>
<td>B (SE) OR 95% CI</td>
<td>B (SE) OR 95% CI</td>
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<tr>
<td>Perceived addictiveness of conventional cigarette smoking</td>
<td>-.09 (.04) .91&lt;sup&gt;a&lt;/sup&gt; .85–.98</td>
<td>.21 (.06) 1.24&lt;sup&gt;b&lt;/sup&gt; 1.09–1.40</td>
<td>.29 (.06) 1.33&lt;sup&gt;a&lt;/sup&gt; 1.18–1.50</td>
</tr>
<tr>
<td>Perceived harm of conventional cigarette smoking</td>
<td>.06 (.04) 1.06 .97–1.15</td>
<td>.09 (.08) 1.09 .94–1.27</td>
<td>.15 (.07) 1.16&lt;sup&gt;a&lt;/sup&gt; 1.01–1.34</td>
</tr>
<tr>
<td>Perceived harm of e-cigarette use</td>
<td>-.46 (.05) .63&lt;sup&gt;c&lt;/sup&gt; .58–.69</td>
<td>-.34 (.08) .71&lt;sup&gt;c&lt;/sup&gt; .61–.84</td>
<td>-.08 (.09) .92 .78–1.09</td>
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<tr>
<td>Perceived influence of antismoking ads</td>
<td>-.08 (.03) .95&lt;sup&gt;c&lt;/sup&gt; .90–.99</td>
<td>.45 (.06) 1.57&lt;sup&gt;c&lt;/sup&gt; 1.41–1.74</td>
<td>.38 (.05) 1.46&lt;sup&gt;c&lt;/sup&gt; 1.32–1.63</td>
</tr>
<tr>
<td>Peer smoking</td>
<td>.32 (.04) 1.38&lt;sup&gt;c&lt;/sup&gt; 1.28–1.49</td>
<td>-.57 (.08) .57&lt;sup&gt;c&lt;/sup&gt; .49–.66</td>
<td>-.84 (.07) .43&lt;sup&gt;c&lt;/sup&gt; .38–.50</td>
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<tr>
<td>Risk-taking propensity</td>
<td>.27 (.03) 1.31&lt;sup&gt;c&lt;/sup&gt; 1.24–1.39</td>
<td>.07 (.07) 1.07</td>
<td>.93–1.24</td>
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<tr>
<td>Sex (reference = male)</td>
<td>-.26 (.07) .77&lt;sup&gt;c&lt;/sup&gt; .67–.89</td>
<td>-.60 (.16) .55&lt;sup&gt;c&lt;/sup&gt; .40–.75</td>
<td>-.36 (.14) .70&lt;sup&gt;a&lt;/sup&gt; .53–.92</td>
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<td>Grade (reference = 8)</td>
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<td>.16 (.08) 1.18</td>
<td>1.00–1.39</td>
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<td>Race/ethnicity (reference = white)</td>
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<td>Black</td>
<td>-.47 (.12) .63&lt;sup&gt;c&lt;/sup&gt; .50–.80</td>
<td>-.28 (.25) .76</td>
<td>.47–1.23</td>
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<tr>
<td>Hispanic</td>
<td>.26 (.09) 1.29&lt;sup&gt;b&lt;/sup&gt; 1.08–1.55</td>
<td>.71 (.21) 2.02&lt;sup&gt;b&lt;/sup&gt; 1.35–3.03</td>
<td>.79 (.19) 2.20&lt;sup&gt;b&lt;/sup&gt; 1.52–3.19</td>
</tr>
<tr>
<td>Parent education</td>
<td>.00 (.03) 1.00</td>
<td>.94–1.07</td>
<td>.19 (.07) 1.21&lt;sup&gt;b&lt;/sup&gt; 1.05–1.38</td>
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Higher scores on the variables indicate higher perceived addictiveness of conventional cigarette smoking, higher perceived harm, higher perceived influence of antismoking ads, higher risk-taking propensity, higher peer smoking, and higher parent education level.

CI = confidence interval; OR = odds ratio; SE = standard error.

<sup>a</sup> p < .05.
<sup>b</sup> p < .01.
<sup>c</sup> p < .001.
adolescent e-cigarette users and is demonstrable even without subjective comparison with the average smoker as reported in prior comparative studies [11,13,26,27]. We established that e-cigarette users (compared with nonusers) are more optimistic about the ease of quitting smoking in the future, have more peers who smoke cigarettes, have a higher risk-taking propensity, and have been less influenced by anti-smoking ads. Also, e-cigarette users share similar harm perceptions of conventional cigarette smoking with cigarette smokers, and a similar risk-taking propensity with cigarette smokers and dual users. The effect of these perceptions on the transition from e-cigarette use to conventional cigarette smoking should be further explored in longitudinal studies.

Our study has some limitations. First, our e-cigarette and cigarette use variables were measured via self-report, and addiction-related variables were measured via a few items, although notably these items are similar to those used in previous studies [11–13,26]. Second, the data set lacks a measure of the perceived addictiveness of e-cigarettes, the addition of which will be a crucial next step for future research. Further, causal inferences cannot be made from our findings due to the cross-sectional nature of this study. However, our large, national sample makes our findings generalizable to the white, black, and Hispanic 8th- and 10th-grade adolescent population in the U.S.

In conclusion, e-cigarette users have muted perceptions of the addictiveness of conventional cigarette smoking compared with nonusers, and they perceive e-cigarette use to be less harmful than all other groups except dual users. Adolescent e-cigarette users may be vulnerable to initiating conventional cigarette smoking due to these muted addiction perceptions and due to their similarity to cigarette smokers and dual users on such risk factors as risk-taking propensity and friends who smoke cigarettes. Future research should include the development of measures that specifically assess perceived risks of nicotine addiction associated with new tobacco products including e-cigarettes. Further, longitudinal studies are needed to assess the prospective relationship between smoking-related perceptions of conventional cigarette smoking among e-cigarette users and the onset of conventional cigarette smoking in order to extend upon the cross-sectional results presented here. Practically, anti-smoking messages should be expanded to address the potential addiction risks associated with all tobacco products, not just conventional cigarettes.

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