

Original investigation

Association Between Electronic Cigarette Use and Openness to Cigarette Smoking Among US Young Adults

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Abstract

Introduction: Use of electronic nicotine delivery systems (ENDS), including electronic cigarettes (e-cigarettes), is increasing. One concern is the appeal of these products to youth and young adults and the potential to influence perceptions and use of conventional cigarettes.

Methods: Using data from the 2012–2013 National Adult Tobacco Survey, characteristics of adults aged 18–29 years who had never established cigarette smoking behavior were examined by ever use of e-cigarettes, demographics, and ever use of other tobacco products (smokeless tobacco, cigars, hookah, and cigarettes). Multivariate logistic regression was used to examine the relationship between e-cigarette use and openness to cigarette smoking among young adults, defined as the lack of a firm intention not to smoke soon or in the next year.

Results: Among young adults who had never established cigarette smoking behavior (unweighted $n = 4,310$), 7.9% reported having ever tried e-cigarettes, and 14.6% of those who reported having ever tried e-cigarettes also reported current use of the product. Ever e-cigarette use was associated with being open to cigarette smoking (adjusted odds ratio = 2.4; 95% confidence interval = 1.7, 3.3), as was being male, aged 18–24 years, less educated, and having ever used hookah or experimented with conventional cigarettes.

Conclusions: Ever use of e-cigarettes and other tobacco products was associated with being open to cigarette smoking. This study does not allow us to assess the directionality of this association, so future longitudinal research is needed to illuminate tobacco use behaviors over time as well as provide additional insight on the relationship between ENDS use and conventional cigarette use among young adult populations.

Introduction

Electronic nicotine delivery systems (ENDS), including electronic cigarettes (e-cigarettes), have surged in popularity among both

youth and adults in the United States since their marketplace debut in 2007. During 2011–2012, the prevalence of ever e-cigarette use among US youth in grades 6–12 doubled from 3.3% to 6.8%,¹ with similar trends in e-cigarette use among adults.^{2–4} The 2012–2013

National Adult Tobacco Survey (NATS) found that US young adults aged 18–24 reported the highest prevalence of e-cigarette use (every day, some day, or rarely) compared to the overall adult population (8.3% vs. 4.2%, respectively).⁵

Increased e-cigarette use has been accompanied by increased advertising for these products; e-cigarette advertising expenditures across multiple media channels, including magazines, television, newspapers, and the Internet, has increased nearly three-fold, from \$6.4 million in 2011 to \$18.3 million in 2012.⁶ Some e-cigarette brands have been advertised as a cost-effective and socially acceptable alternative to conventional cigarette smoking,^{7,8} and certain online marketing has promoted anecdotal claims of smoking cessation benefits, along with direct and indirect health claims.^{6,9–11} Recent literature suggests young adults who had never used e-cigarettes, but expect positive outcomes from using them, have greater intentions to try e-cigarettes in the future.¹² In addition, researchers have suggested that increased variation across ENDS products, with a growing diversity of flavoring options, may lead to product appeal among young adults.¹³

While the US Food and Drug Administration (FDA) does not currently regulate ENDS, in April 2014 the Agency released a proposed rule to extend its jurisdictional authorities to other tobacco products, including e-cigarettes.¹⁴ Under the current proposal, FDA would have the authority to regulate the manufacture, marketing, and distribution of e-cigarettes. When evaluating new tobacco products, FDA is required to assess the impact of the product and its marketing on the health of the population as a whole. This includes consideration of the potential for increased harm or benefit among current tobacco users, including delayed or decreased cessation, and the potential for harm among nonusers of tobacco, including the potential for increased initiation of tobacco use and relapse among former tobacco users. In the case of ENDS, while there is potential for substantial benefits to public health if current established adult cigarette smokers who would otherwise have not quit completely switch to use of ENDS, there is also concern that the appeal of ENDS among youth and young adults could lead to initiation of the use of potentially more harmful tobacco products, such as conventional cigarettes. Understanding the potential uptake of ENDS among young adults is particularly important considering that nearly all adults who become daily smokers first started smoking by 26 years of age.¹⁵

To date, limited evidence exists regarding the relationship between e-cigarette use and conventional cigarette smoking intentions among nonsmoking young adult e-cigarette users. However, theory suggests the potential for such a relationship to exist. For example, the Theory of Planned Behavior (TPB) posits that behavioral intentions arise from a combination of a person's attitudes and subjective norms about the behavior, as well as their perceived behavioral control.¹⁶ Indeed, extant evidence supports this theory in the context of tobacco use, showing that intentions are a strong predictor of adolescent smoking behavior.^{17,18} The behavioral similarities between e-cigarette use and conventional cigarette smoking (e.g., nicotine delivery via inhalation, hand-to-mouth delivery), suggest the possibility that attitudes about the use of e-cigarettes may influence attitudes about conventional cigarettes. In turn, as suggested by TPB, these positive attitudes may lead to stronger intentions to try conventional cigarette smoking. Alternatively, it is possible that positive attitudes surrounding e-cigarettes may in fact reinforce negative attitudes toward cigarette smoking (e.g., due to the smell of conventional cigarettes, ash produced,

etc.). Regardless, an initial step in understanding the relationship between e-cigarettes and conventional cigarettes is to explore if an association exists between e-cigarette use and openness to cigarette smoking.

To explore whether e-cigarette use among young adults is independently associated with being open to future conventional cigarette smoking, this study analyzed data from the 2012–2013 NATS. This data release cycle of NATS included measures on self-reported openness to smoking conventional cigarettes “soon” or “in the next year” among young adults who were never established smokers (defined as those who have smoked less than 100 cigarettes in their lifetime and currently smoke “not at all”). This relationship was assessed by first comparing the characteristics of young adult never established smokers who have ever tried (or have never tried) e-cigarettes. Next, the relationship between e-cigarette use as well as the relationship between ever use of other tobacco products, and openness to smoking was examined.

Methods

National Adult Tobacco Survey

The 2012–2013 NATS is a stratified, nationally representative random-digit dialed telephone survey of noninstitutionalized adults 18 years of age and older. The sampling design was comprised of independent samples drawn from 75% landline and 25% cell phone-only households in the 50 US states and District of Columbia. The 2012–2013 NATS was a collaborative partnership between FDA's Center for Tobacco Products and CDC's Office on Smoking and Health. A total of 57,994 completed interviews and 2,198 eligible partial interviews (at least 60% complete) were obtained between October 2012 and July 2013, yielding a total sample of 60,192 qualified interviews and a corresponding response rate of 44.9%.

Study Population

This study was restricted to the 4,310 young adult (aged 18–29) respondents who had never established cigarette smoking behavior. Young adult respondents were determined to be never established smokers if they responded “no” to the question, “Have you smoked at least 100 cigarettes in your entire life?”, and also responded “not at all” to the question, “Do you now smoke cigarettes every day, some days, or not at all?”. Young adults who reported current (every day or some days) use of other combustible products, including cigars and hookah, were excluded from the sample due to the potential for current use of other combustible tobacco products to confound the relationship between e-cigarette use and openness to smoking in the future given the behavioral similarity between use of these products to conventional cigarette smoking. Current users of noncombustible products, including traditional smokeless tobacco, snus, and dissolvable tobacco products, were not excluded from the sample, but noncombustible product use was included as a covariate in the analysis.

Measures

E-Cigarette Use

All survey respondents were asked the question “Before today, had you ever heard of electronic cigarettes, or e-cigarettes?” Those who answered “yes” were then asked “Have you ever used an electronic cigarette, even just one time in your entire life?” Ever e-cigarette users were defined as those who responded “yes,” while those

responding “no” were defined as never e-cigarette users. Individuals who indicated never having heard of e-cigarettes prior to interview were treated as never e-cigarette users in the analysis as they were not asked the e-cigarette use question.

Openness to Smoking

Openness to future cigarette smoking was assessed among young adults in the study population using two questions: “Do you think you will smoke a cigarette soon?” and “Do you think you will smoke a cigarette in the next year?” Response options were: “Definitely yes,” “Probably yes,” “Probably not,” and “Definitely not.” A binary composite variable was created, and those who responded with any response option other than a firm intention not to smoke (“Definitely not”) were categorized as being open to smoking cigarettes and, therefore, considered at risk for future smoking. This definition draws on previous research on susceptibility measures classifying susceptibility/high-risk intentions as the lack of firm intention not to smoke.^{17–20} A sensitivity analysis was also conducted classifying only “Definitely yes” and “Probably yes” as being open to smoking and “Probably not” and “Definitely not” as not being open to smoking cigarettes.

Other Tobacco Product Use

Other tobacco product use was assessed with measures of ever use of smokeless tobacco, hookah, cigars, and ever experimentation with cigarettes. Ever use of smokeless tobacco was defined as having used chewing tobacco, dip, or snuff 20 times or having tried snus or dissolvable tobacco even one time. Ever use of hookah was assessed using the question, “Have you ever smoked tobacco in a hookah in your entire life?”. Ever use of cigars was assessed using the question, “Have you smoked cigars, cigarillos, or little filtered cigars at least 50 times in your entire life?” Lastly, ever cigarette experimentation was assessed using the question, “Have you ever tried cigarette smoking, even one or two puffs?” Respondents who selected “yes” were considered to have experimented with cigarettes at some point in their lifetime.

Demographic Characteristics

Demographic characteristics included: sex (male and female), age group (18–24 and 25–29 years), race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, and other non-Hispanic), educational attainment (less than 12th grade [no diploma]; high school diploma, General Education Development Certificate, or equivalent; and some college or higher), and US Census region (South, Midwest, Northeast, and West). The “non-Hispanic other” category included respondents who were non-Hispanic and Asian, Native American or Alaska Native, Hawaiian or Pacific Islander, or multiple races.

Statistical Analyses

All analyses were conducted via SAS 9.3 using *proc surveyfreq* and *proc surveylogistic* commands to control for the complex survey design. Final weights were applied to reflect initial selection probabilities, nonresponse adjustment, weight trimming, and post-stratification to national adult population estimates. First, sample characteristics of young adults were examined by ever use of e-cigarettes. Next, prevalence estimates and 95% confidence intervals (CIs) of self-reported openness to smoking were calculated, stratified by ever e-cigarette use, sex, age group, race/ethnicity, educational attainment, US Census region, ever use of smokeless tobacco (chewing tobacco, snuff, dip, snus, or dissolvables), ever use of hookah, ever

use of cigars, and ever experimentation with cigarettes. Differences between estimates were considered statistically significant if results from a bivariate Rao–Scott chi-square test, which incorporates a correction to account for the survey design effects, were $p < .05$. Lastly, we used bivariate logistic regression to estimate unadjusted (odds ratios [ORs]) and multivariate logistic regression to estimate adjusted ORs (AORs) of openness to smoke cigarettes (i.e., lack of a firm intention not to smoke) among ever e-cigarette users, controlling for demographic characteristics and other tobacco product use. The adjusted regression model included the following covariates: sex, age group, race/ethnicity, educational attainment, US Census region, ever use of e-cigarettes, ever use of smokeless tobacco, ever use of hookah, ever use of cigars, and ever experimentation with cigarettes. Additionally, to examine any differences among males and females by ever use of e-cigarettes, a sex interaction term was included in the adjusted model. Estimates with a relative *SE* of >30% or a denominator of <50 were not reported consistent with the protocol for other large, nationally representative surveys.²¹

Of the 4,310 eligible young adults in NATS who have never established cigarette smoking behavior and do not regularly use other combustible tobacco products, approximately 7% partially completed the survey ($n = 296$). Of these partial completes, 170 cases were excluded from the multivariate analysis due to missing data on a study measure. There was no statistically significant difference ($p < .05$) in demographic characteristics or tobacco use behaviors between respondents who completed the entire survey and those who partially completed the survey.

Results

The mean age of the study population was 23.6 ($SD = 3.4$). Among young adults who had never established cigarette smoking behavior and who were not current smokers of cigarettes or other combustible tobacco products (unweighted $n = 4,310$), 7.9% (95% CI = 6.9, 8.9) reported having ever tried e-cigarettes—14.6% (95% CI = 9.8, 19.3) of whom reported current use of the product (data not shown). Among those who have ever tried e-cigarettes (unweighted $n = 328$), 61.2% were men (95% CI = 54.5, 67.9), 73.3% were aged 18–24 (95% CI = 67.9, 78.7), 57.6% were non-Hispanic Whites (95% CI = 50.9, 64.2), and 58.6% have completed some college education or higher (95% CI = 51.6, 65.6) (Table 1). Bivariate analyses indicated statistically significant differences by ever e-cigarette use for sex ($p < .0001$), age group ($p < .05$), education ($p < .05$), those who ever used smokeless tobacco ($p < .0001$), those who ever used hookah ($p < .0001$), those who ever used cigars ($p < .0001$), and those who experimented with cigarettes ($p < .0001$). No statistically significant difference was observed by race/ethnicity or US Census region. Nearly half (46.1%; 95% CI = 39.5, 52.8) of young adults who had ever tried an e-cigarette reported being open to smoking cigarettes compared to 14.2% (95% CI = 12.8, 15.6) of those who had never tried an e-cigarette (Table 2). Openness to smoke conventional cigarettes was also high among young adults who had ever tried other tobacco products, such as smokeless tobacco (34.9%; 95% CI = 28.1, 41.8), hookah (28.2%; 95% CI = 25.0, 31.5), cigars (38.5%; 95% CI = 29.2, 47.8), or conventional cigarettes (29.0%; 95% CI = 26.3, 31.7).

Unadjusted logistic regression analysis indicated that e-cigarette use was positively associated with being open to smoking (OR = 5.2; 95% CI = 3.9, 6.9). Additionally, young adults who had ever used other tobacco products were positively associated with openness

Table 1. Characteristics of Never Established Smoking Young Adults,^a by Ever Use of E-Cigarettes—NATS 2012–2013

Respondent characteristics	Among never e-cigarette users (<i>n</i> = 3,981)		Among ever e-cigarette users (<i>n</i> = 328)		<i>p</i>
	%	95% CI	%	95% CI	
Sex					<.0001
Male	45.1	(43.0, 47.1)	61.2	(54.5, 67.9)	
Female	54.9	(52.9, 57.0)	38.8	(32.1, 45.5)	
Age					.002
18–24	63.8	(62.0, 65.6)	73.3	(67.9, 78.7)	
25–29	36.2	(34.4, 38.0)	26.7	(21.3, 32.1)	
Race/ethnicity					.14
White, NH	53.1	(51.2, 55.0)	57.6	(50.9, 64.2)	
Black, NH	12.5	(11.1, 13.8)	7.2	(3.7, 10.6)	
Hispanic	22.3	(20.6, 24.0)	22.1	(16.4, 27.8)	
Other, NH	12.1	(10.8, 13.4)	13.2	(8.8, 17.5)	
Education					.02
<12th grade (no diploma)	11.4	(9.8, 12.9)	^b	^b	
HS diploma, GED, or equivalent	33.1	(31.1, 35.1)	36.8	(29.8, 43.8)	
Some college or higher	55.5	(53.4, 57.6)	58.6	(51.6, 65.6)	
US region					.41
Northeast	17.7	(16.7, 18.6)	19.7	(14.3, 25.1)	
Midwest	20.4	(19.5, 21.4)	19.0	(14.2, 23.7)	
South	37.3	(36.1, 38.4)	32.9	(27.0, 38.9)	
West	24.6	(23.6, 25.6)	28.4	(22.7, 34.1)	
Ever use of smokeless tobacco ^c					<.0001
Yes	4.1	(3.4, 4.8)	18.1	(13.4, 22.7)	
No	95.9	(95.2, 96.6)	81.9	(77.3, 86.6)	
Ever use of hookah					<.0001
Yes	22.7	(21.1, 24.3)	58.5	(51.9, 65.0)	
No	77.3	(75.7, 78.9)	41.5	(35.0, 48.1)	
Ever use of cigars ^d					<.0001
Yes	3.2	(2.5, 3.9)	14.8	(10.1, 19.5)	
No	96.8	(96.1, 97.5)	85.2	(80.5, 89.9)	
Ever experimentation with cigarettes					<.0001
Yes	36.7	(34.8, 38.5)	86.2	(81.7, 90.7)	
No	63.3	(61.5, 65.2)	13.8	(9.3, 18.3)	

p value from chi-square test. Frequencies reflect unweighted data. CI = confidence interval; NH = non-Hispanic; GED = General Education Development certificate.

^aNever established smoking young adults was defined as respondents 18–29 years of age who reported never smoking 100 cigarettes in their lifetime and currently smoking cigarettes “not at all.” Current, regular cigar, and hookah smokers (every day or some day) were also excluded from the sample.

^bEstimate was suppressed; the relative SE was >30% or denominator <50.

^cEver use is defined as having used chewing tobacco, dip, or snuff 20 times or having ever tried snus or dissolvables.

^dEver use of cigars was defined as having used cigars, cigarillos, or filtered little cigars 50 times during their lifetime.

to smoking compared to those who have not tried the products, including smokeless tobacco (OR = 2.9; 95% CI = 2.1, 4.0), hookah (OR = 2.7; 95% CI = 2.2, 3.3), cigars (OR = 3.3; 95% CI = 2.2, 5.0), and cigarettes (OR = 4.5; 95% CI = 3.6, 5.6), respectively. Results also show men were more likely to report openness to smoking than women (OR = 2.1; 95% CI = 1.7, 2.6), those aged 18–24 were more likely to report openness to smoking (OR = 1.6; 95% CI = 1.3, 1.9) than those aged 25–29, and those with some college education or more were less likely to report openness to smoking (OR = 0.6; 95% CI = 0.4, 0.9) when compared to those with less than a high school diploma.

Following multivariate adjustment, those who had tried an e-cigarette were statistically significantly more likely than those who had never tried an e-cigarette to report openness to cigarette smoking (AOR = 2.4; 95% CI = 1.7, 3.3) after controlling for sex, age group, race/ethnicity, educational attainment, US Census region, ever use of smokeless tobacco, ever use of hookah, ever use of cigars, and

ever experimentation with conventional cigarettes. In the adjusted model, males had 1.8 times the odds as females (95% CI = 1.4, 2.3) and young adults aged 18–24 had 1.7 times the odds as those aged 25–29 (95% CI = 1.3, 2.2) to report openness to smoking. Education remained inversely related to openness to smoking, with those achieving some college or higher having lower odds of openness to smoking (AOR = 0.5; 95% CI = 0.3, 0.8) compared to those who had not received a high school diploma. In addition, those who reported ever using a hookah or ever experimentation with conventional cigarettes were statistically significantly more likely to report openness to smoking compared to those who had never tried hookah or experimented with conventional cigarettes (AOR = 1.6; 95% CI = 1.3, 2.1 and AOR = 3.5; 95% CI = 2.7, 4.5, respectively). In a sensitivity analysis, classifying defining only those reporting “Definitely yes” or “Probably yes” responses as being open to smoking resulted in an AOR for ever e-cigarette users of 2.5 (95% CI = 1.5, 4.1) compared to those who have never tried an e-cigarette,

Table 2. Prevalence of Openness to Cigarette Smoking and Factors Associated With Openness to Smoking Among Young Adults^a—NATS 2012–2013

Respondent characteristics	Prevalence of openness to smoking			Unadjusted OR		Adjusted OR	
	%	95% CI	<i>p</i>	OR	95% CI	AOR	95% CI
Ever e-cigarette use			<.0001				
Yes	46.1	(39.5, 52.8)		5.2	(3.9, 6.9)	2.4	(1.7, 3.3)
No	14.2	(12.8, 15.6)		(ref)	–	(ref)	–
Sex			<.0001				
Male	22.2	(19.9, 24.6)		2.1	(1.7, 2.6)	1.8	(1.4, 2.3)
Female	11.9	(10.1, 13.6)		(ref)	–	(ref)	–
Age			<.0001				
18–24	18.8	(16.9, 20.7)		1.6	(1.3, 1.9)	1.7	(1.3, 2.2)
25–29	12.9	(11.0, 14.9)		(ref)	–	(ref)	–
Race/ethnicity			.06				
White, NH	16.1	(14.1, 18.0)		(ref)	–	(ref)	–
Black, NH	13.5	(9.5, 17.5)		0.8	(0.6, 1.2)	1.0	(0.7, 1.5)
Hispanic	20.2	(16.7, 23.7)		1.3	(1.0, 1.7)	1.3	(0.9, 1.7)
Other, NH	17.6	(13.5, 21.6)		1.1	(0.8, 1.5)	1.4	(1.0, 1.9)
Education			.01				
<12th Grade (no diploma)	21.5	(15.6, 27.4)		(ref)	–	(ref)	–
High school diploma, GED, or equivalent	18.6	(15.6, 21.5)		0.8	(0.6, 1.2)	0.7	(0.4, 1.1)
Some college or higher	14.7	(13.1, 16.3)		0.6	(0.4, 0.9)	0.5	(0.3, 0.8)
US region			.62				
South	18.5	(14.7, 22.2)		(ref)	–	(ref)	–
Midwest	17.3	(14.1, 20.5)		1.1	(0.8, 1.5)	1.2	(0.9, 1.6)
Northeast	15.8	(13.5, 18.0)		1.2	(0.9, 1.6)	1.3	(0.9, 1.8)
West	16.6	(13.8, 19.3)		1.1	(0.8, 1.4)	1.0	(0.7, 1.3)
Ever use of smokeless tobacco ^b			<.0001				
Yes	34.9	(28.1, 41.8)		2.9	(2.1, 4.0)	1.0	(0.7, 1.5)
No	15.7	(14.3, 17.2)		(ref)	–	(ref)	–
Ever use of hookah			<.0001				
Yes	28.2	(25.0, 31.5)		2.7	(2.2, 3.3)	1.6	(1.3, 2.1)
No	12.8	(11.3, 14.3)		(ref)	–	(ref)	–
Ever use of cigars ^c			<.0001				
Yes	38.5	(29.2, 47.8)		3.3	(2.2, 5.0)	1.6	(1.0, 2.6)
No	15.8	(14.4, 17.2)		(ref)	–	(ref)	–
Ever experimentation with cigarettes			<.0001				
Yes	29.0	(26.3, 31.7)		4.5	(3.6, 5.6)	3.5	(2.7, 4.5)
No	8.4	(7.0, 9.8)		(ref)	–	(ref)	–

Statistically significant estimates noted in bold. *p* value from chi-square test. OR = odds ratio; CI = confidence interval; AOR = adjusted odds ratio; NH = non-Hispanic; GED = General Education Development certificate.

^aNever smoking young adults was defined as respondents 18–29 years of age who reported never smoking 100 cigarettes in their lifetime and currently smoking cigarettes “not at all.” Current, regular cigar and hookah smokers (every day or some day) were also excluded from the sample.

^bEver use of smokeless tobacco was defined as having used chewing tobacco, dip, or snuff 20 times or having ever tried snus or dissolvables.

^cEver use of cigars was defined as having used cigars, cigarillos, or filtered little cigars 50 times during their lifetime.

indicating that in applying this alternative definition the association did not change significantly. Associations for the ever use of other tobacco products and demographic characteristics included in the multivariate model also remained the same in the sensitivity analysis.

A final model tested the interaction between sex and e-cigarette use (data not shown). This analysis found that the relationship between ever e-cigarette use and openness to cigarette smoking did not vary significantly by sex as the *p* value of the interaction term was greater than .05.

Discussion

This study is the first to examine the relationship between e-cigarette use and openness to smoke, defined as the lack of a firm intention

not to smoke, in a nationally representative sample of young adults who had never established cigarette smoking behavior. Our findings indicate that young adults who have ever tried e-cigarettes was positively associated with openness to smoking compared to those who have never tried e-cigarettes after adjusting for sex, age group, race/ethnicity, educational attainment, US Census region, and ever use of smokeless tobacco, ever use of hookah, ever use of cigars, and experimentation with conventional cigarettes. Findings from this study also indicate nearly 60% of ever e-cigarette users in the study sample reported having tried hookah (vs. 23% of never e-cigarette users), as well as an independent association between ever hookah use and openness to smoking, which suggests young adults who experiment with other tobacco products may also be at risk for future cigarette smoking.

As noted, statistically significant differences in those who were classified as being open to smoking were observed not only by e-cigarette use, but also across population subgroups of young adults. Men, young adults aged 18–24, those with lower educational attainment, those who had ever tried hookah, and those ever experimenting with conventional cigarettes were more likely to lack a firm intention not to smoke. In this study, the sample population for this analysis consisted of young adults aged 18–29 years who have not established cigarette smoking behavior. In the context of e-cigarette use and openness to cigarette smoking, this population is especially important given that this is a critical period for tobacco use experimentation and initiation of regular use to occur.¹⁵ Moreover, a recent study found never-smoking middle and high school students who have used e-cigarettes are nearly twice as likely to report smoking intentions compared with youth who have never used e-cigarettes.²² Although previous research has shown that most smokers try their first cigarette during childhood or adolescence,¹⁵ as the diversity of tobacco products on the market expands and attracts new users, young adults who otherwise may have not initiated or established regular use of conventional tobacco products may initiate novel tobacco products, such as ENDS.

A strong association between ever e-cigarette use and the lack of a firm intention not to smoke was observed in this study among never established smokers, adjusting for ever use of other tobacco products, as well as prior experimentation with cigarettes. There are several explanations that could give rise to this association; for example, if, as the TPB suggests,¹⁵ positive attitudes toward e-cigarette use increase openness to smoke cigarettes, then e-cigarettes might indeed negatively impact population health by acting as an entry to nicotine use and to use of combustible tobacco.²³ A recent study of passive exposure to e-cigarette use found that such exposure increased desire for cigarettes, as well as e-cigarettes in young adult smokers,²⁴ and an earlier study found that watching an advertisement for e-cigarettes that emphasized they can be used anywhere resulted in increased urges to smoke²⁵ suggesting that this concern is plausible. Given the recent introduction of ENDS into the marketplace and the lack of data from prospective longitudinal studies, a direct link between use of e-cigarettes and progression to use of cigarettes has not been shown.^{26,27} Alternative explanations are also possible, such as young adults at risk for future cigarette smoking are turning to ENDS use. As noted in this study, those with a prior experience with other tobacco products were also more likely to report openness to smoking, which may suggest a common set of factors that put young adults at risk for future conventional cigarette smoking.

Although few studies have followed young adults over time to determine if those at risk for future smoking actually go on to smoke, the few studies that have done so have found that a lack of a firm intention not to smoke is a powerful predictor of increased risk of progression to actual use.^{17,18} Future research using longitudinal studies will help determine tobacco use trajectories over time to assess whether the use of ENDS among youth and young adults is associated with future combustible tobacco smoking, what the impact of ENDS use is on young adults at risk for smoking, and if the same risk factors that put individuals at risk for smoking initiation also puts them at risk for ENDS initiation, as well as the initiation of other tobacco products.

Limitations

This study is not without limitations. The first and most important limitation arises from the cross-sectional nature of the study.

While a statistically significant association was observed between young adults who have tried e-cigarettes and openness to cigarette smoking, the cross-sectional nature of the survey limits the ability to establish the temporal relationship between e-cigarette use and openness to smoking. A second limitation results from the use of observational data. While we adjusted for relevant covariates in our analyses, it is possible that the association observed between e-cigarette use and openness to smoking is the result of an unmeasured confounder. Additionally, there are limitations inherent to relying on self-report measures of behavior.²⁸ In this study, young adults reported their openness to smoke conventional cigarettes, defined as a lack of a firm intention not to smoke, which is likely influenced by many factors such as attitudes, subjective norms surrounding the behavior, and access to tobacco products. Nonetheless, self-reported data can still provide valuable insight as to their behavioral intentions, which is an important antecedent to behavior change.^{16,29,30} Next, given that the survey measures for e-cigarettes in the 2012–2013 NATS only explicitly address “e-cigarettes,” it is possible that these measures underestimate ENDS use by not also including terminology used to describe ENDS, such as “e-hookah,” “vape pens,” or “e-pens” which may be growing in popularity.³¹ Lastly, this study examined the association between e-cigarette use and openness to cigarette smoking among never established cigarette smokers who may have previously experimented with conventional cigarettes at some point in their lifetime. Due to a limited sample size of young adults who have never tried cigarette smoking, we were not able to test this association among never experimenters; however, after controlling for prior cigarette experimentation increased odds of being open to smoking among e-cigarette users remained, indicating an independent association. Future research on openness to smoke cigarettes among e-cigarette users without a prior history of cigarette use may help further explore these relationships.

Conclusions

Our findings indicate that ever use of e-cigarettes, along with ever use of other combustible products, is associated with being open to smoking cigarettes, even after adjusting for other tobacco product use, as well as demographic characteristics. Although this study does not allow us to assess directionality of this association, longitudinal research and on-going surveillance efforts to monitor patterns of use of ENDS will help illuminate tobacco use behaviors over time, as well as provide additional insight on the relationship between ENDS use, including e-cigarettes, and conventional cigarette use in young adult populations.

Declaration of Interests

None declared.

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