



Initiation of Traditional Cigarette Smoking after Electronic Cigarette Use Among Tobacco-Naïve US Young Adults

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ABSTRACT

BACKGROUND: Although electronic cigarettes (e-cigarettes) may help some smokers quit, some young adult never-smokers are now using e-cigarettes recreationally, potentially increasing their risk for initiation of smoking. We aimed to determine the association between baseline e-cigarette use and subsequent initiation of cigarette smoking among initially never-smoking young adults.

METHODS: We conducted a prospective cohort study with assessments at baseline (March 2013) and follow-up (October 2014). We used sampling frames representing 97% of the US population to recruit a nationally representative sample of never-smoking young adults aged 18 to 30 years. The independent variable was baseline ever use of e-cigarettes. The main outcome measure was initiation of traditional cigarette smoking between baseline and 18-month follow-up.

RESULTS: Baseline surveys were completed by 1506 never-smoking young adults, of whom 915 (60.8%) completed follow-up. There were no demographic differences between responders and nonresponders. After applying survey weights—which accounted for both nonresponse and overcoverage or undercoverage—2.5% of the represented population of never-smokers (801,010 of 32,040,393) used e-cigarettes at baseline. Cigarette smoking was initiated by 47.7% of e-cigarette users and 10.2% of nonusers ($P = .001$). In fully adjusted multivariable models, e-cigarette use at baseline was independently associated with initiation of smoking at 18 months (adjusted odds ratio, 6.8; 95% confidence interval, 1.7–28.3). Results remained similar in magnitude and statistically significant in all sensitivity analyses.

CONCLUSIONS: Baseline e-cigarette use was independently associated with initiation of traditional cigarette smoking at 18 months. This finding supports policy and educational interventions designed to decrease use of e-cigarettes among nonsmokers.

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INTRODUCTION

Electronic cigarette (e-cigarette) use is increasing among youth and young adults.^{1–5} For example, in 2014 the prevalence of past 30-day e-cigarette use (13.4%) was higher than the prevalence of past 30-day cigarette use (9.2%) in a nationally representative study of high school seniors.⁶ Compared with traditional combustible cigarettes, e-cigarettes emit lower levels

of most toxicants.^{7,8} Therefore, these devices have been proposed as tools to help established smokers reduce the toxicant load to which they are exposed.⁹ However, early evidence on the potential value of e-cigarettes for cessation or reduction of cigarette smoking is mixed; although some studies support potential value of e-cigarettes for smoking cessation,⁹ others find e-cigarette use to be associated with no cessation or even reduced cessation.¹⁰⁻¹²

It is also the case that many current e-cigarette users are not using them for smoking cessation or reduction.⁶ Thus, these products might generate a pathway to cigarette smoking among nonsmokers. E-cigarettes may seem to be an attractive alternative to traditional cigarette smoking among nonsmokers because they are flavored, more palatable to consume, and perceived as safe.¹³⁻¹⁶ Although the US Food and Drug Administration has begun to regulate e-cigarettes,¹⁷ perception of safety may also stem from a relative lack of regulation.^{17,18}

Prior cross-sectional studies have associated e-cigarette use with susceptibility to future cigarette smoking among non-smoking adolescents and young adults.^{1,19-23} In addition, an increasing number of longitudinal studies support these associations.²⁴⁻²⁹ For example, one study found that high school students in Los Angeles who had ever used e-cigarettes at baseline (vs nonusers) were significantly more likely to initiate combustible tobacco use over the subsequent 6 months (30.7% vs 8.1%).²⁷ Another found that—among a national sample with no future intention to smoke—those who used e-cigarettes at baseline were significantly more likely to initiate combustible tobacco use over 12 months of follow-up (37.5% vs 9.6%).²⁸ The remaining studies found similar findings among high school students in Hawaii,²⁹ high school students in Southern California,²⁵ a national sample of 12th grade students,²⁴ and a cohort of university students from one mid-Atlantic university.²⁶ An appropriate next step would be to examine this question in a nationally representative population to extend the generalizability of findings. Also, because prior studies have focused on adolescents, it would be valuable to explore these questions in young adulthood, which is increasingly understood as an important time of transition related to tobacco use.³⁰⁻³²

Therefore, we conducted a prospective cohort study to determine the association between baseline e-cigarette use and initiation of cigarette smoking among a nationally representative population of young adults who never smoked cigarettes. We hypothesized that baseline e-cigarette use would be independently associated with initiation of cigarette smoking at follow-up, adjusting for sampling weights and participant sociodemographic, personal, and environmental characteristics.

METHODS

Participants

We collected baseline and follow-up data on participants recruited from a nationally representative probability-based online nonvolunteer access panel recruited and maintained by Growth from Knowledge. To increase respondent representativeness, this panel was populated using a combination of random digit dialing and address-based sampling,³³ resulting in a sampling frame of an estimated 97% of US households. Because computers and internet access were provided to panel members that did not have them, all assessments could be conducted online.

Procedures

In March 2013, noninstitutionalized English-speaking adults aged 18 to 30 years were randomly selected to complete a baseline survey about tobacco use. Eighteen months later (October 2014), participants were invited to provide follow-up data to reassess tobacco-use behaviors. Those who completed both baseline and follow-up surveys were given a \$20 cash-equivalent incentive. This study was approved by the University of Pittsburgh Institutional Review Board and was granted a Certificate of Confidentiality from the National Institutes of Health. All participants provided written informed consent.

Measures

Initiation of Cigarette Smoking (Dependent Variable). At baseline and follow-up, participants were asked about ever use of cigarettes. We defined initiation of cigarette smoking using established criteria as progressing from being a never-smoker at baseline to having had at least a puff of a cigarette by follow-up.³⁴⁻³⁶

Electronic Cigarette Use at Baseline (Independent Variable). We asked participants “Have you ever smoked from an e-cigarette (electronic cigarette)?” and provided response choices of only yes or no. Our independent variable for this study was whether an individual had ever used an electronic cigarette at baseline.

Covariates. We assessed 10 sociodemographic, personal, and environmental covariates that have been independently associated with initiation of cigarette smoking.^{28,30,35,37,38}

Sociodemographic Variables. Growth from knowledge provided data on participant age, sex, race and ethnicity, and education level. We divided age into 4 categories based on data distribution: 18 to 20, 21 to 23, 24 to 36, and 27 to 30 years. We categorized self-reported race and ethnicity as white,

CLINICAL SIGNIFICANCE

- Some 48% of e-cigarette users but only 10% of nonusers initiated smoking by follow-up.
- Baseline e-cigarette use was independently associated with smoking uptake (adjusted odds ratio, 6.8).
- Interventions should aim to reduce e-cigarette use among young adult nonsmokers.

non-Hispanic (white); black, non-Hispanic (black); Hispanic; and other, which included multiracial individuals. We categorized education level as high school or less, at least some college, or a college degree or higher.

Personal Variables. We assessed self-esteem using a validated 1-item scale.³⁹ We measured sensation seeking with a 4-item validated Likert-type scale that included items such as “I like to do dangerous things” (Cronbach’s $\alpha = 0.79$).⁴⁰ We assessed rebelliousness using a 3-item validated Likert-type subscale of Smith and Fogg⁴¹ that included items such as “I tend to go against the rules” (Cronbach’s $\alpha = 0.79$).

Environmental Variables. We categorized yearly household income as low (<\$30,000), medium (\$30,000–\$74,999), and high (\$75,000). We categorized relationship status as single versus those in a committed relationship. We divided participants into those residing with a parent or guardian, those residing with a significant other, or another living arrangement.

Notes on Operationalization of Covariates. For primary analyses, all covariates were categorical. For example, continuous raw scores for sensation seeking based on Likert-type scales were categorized in tertiles. This was done for ease of comparison with prior work^{37,42} and so results could be more easily interpreted. However, we also conducted sensitivity analyses operationalizing all covariates as continuous to ensure robustness of our results.

Statistical Analyses

We compared the independent variable and all covariates among individuals who did and did not initiate smoking by 18-month follow-up. We calculated the statistical significance of these differences using Pearson’s chi-square tests. We then used bivariable and multivariable logistic regression to assess associations between baseline e-cigarette use and initiation of cigarette smoking. Primary multivariable analyses adjusted for all 10 measured covariates. We tested for significant 2-way interactions between the independent variable and each covariate, and none of these interaction terms were statistically significant. We assessed the presence of an overall linear trend between each ordered categorical independent variable and the dependent variable using an established method.⁴³

Survey weights were applied to adjust for nonresponse, as well as noncoverage, undersampling, or oversampling resulting from the sample design. For all analyses, we defined statistical significance with a 2-tailed α of 0.05. Data were analyzed using Stata 12.⁴⁴

We conducted 3 sets of sensitivity analyses to explore the robustness of our findings. First, we modeled all covariates that could possibly be continuous (eg, age, sensation seeking, and rebelliousness) as such. Second, we conducted all analyses without survey weights. Third, we conducted all analyses only including covariates that demonstrated bivariable associations of $P < .15$ with the dependent variable. All sensitivity

analyses showed consistent results in terms of level of significance and magnitude of odds ratios with the primary analyses presented in this article.

RESULTS

Sample of Participants

The initial survey was open to Growth from Knowledge’s complete sample of 6420 individuals aged 18 to 30 years at the time of the survey. Enrollment was stopped after 3254 consented. This included 1506 young adults who had never smoked cigarettes, who represented the baseline sample for the current study. Of those baseline nonsmokers, 915 (60.8%) completed follow-up and were included in our analyses. Respondents and nonrespondents at follow-up were no different in terms of age ($P = .38$), sex ($P = .36$), or race/ethnicity ($P = .20$). Additionally, any slight nonsignificant differences were accounted for in the survey weighting (see “Statistical Analyses”). The unweighted sample was 61.6% female, 64.8% white, 10.9% black, and 14.2% Hispanic, and had a median age of 23 years (interquartile range, 20–26). The weighted sample was 50.3% female, 55.2% white, 14.6% black, and 19.7% Hispanic, and had a median age of 23 years (interquartile range, 20–27) (**Table 1**).

Baseline E-Cigarette Use and Initiation of Cigarette Smoking at Follow-Up

Of the 915 individuals in the study sample, 16 (1.8%) had ever used an e-cigarette at baseline, defined as having had even a puff. After applying sampling weights, 2.5% had ever used an e-cigarette at baseline; this represented 801,010 of the population of 32,040,393. In weighted analyses, compared with nonusers, e-cigarette users were more frequently in the “medium” category of yearly household income (**Table 1**). In the unweighted sample, 87 (9.5%) initiated cigarette smoking by 18 months. After applying survey weights, initiation of cigarette smoking was 11.2%.

Association of Baseline E-Cigarette Use and Initiation of Cigarette Smoking at Follow-Up

Among the 16 e-cigarette users at baseline, 6 (37.5%) initiated cigarette smoking at 18-month follow-up compared with 81 (9.0%) of 899 e-cigarette nonusers ($P < .001$) (**Table 2**). After applying sampling weights, cigarette smoking was initiated in 47.7% of e-cigarette users and 10.2% of nonusers at baseline ($P = .001$) (**Table 2**). In bivariable analyses, the only other characteristics significantly associated with initiation of cigarette smoking were Hispanic ethnicity and increased rebelliousness (**Table 2**). There was a nonsignificant trend toward an association between sensation seeking and initiation of cigarette smoking ($P = .07$) (**Table 2**).

Multivariable logistic regression analyses incorporating survey weights demonstrated that compared with baseline none-cigarette smokers, baseline e-cigarette smokers had greater odds of initiating cigarette smoking (adjusted odds

Table 1 Characteristics of Study Participants (Unweighted and Weighted) by E-Cigarette Use at Baseline

Characteristics	Unweighted Data				Weighted Data			
	E-Cigarette Use at Baseline*			P Value†	E-Cigarette Use at Baseline*			P Value†
	All n = 915	Yes n = 16	No n = 899		All n = 32,040,393	Yes n = 801,010	No n = 31,239,383	
Age, y				.73				.18
18-20	21.8	31.3	21.6		31.6	58.7	31.0	
21-23	32.7	31.3	32.7		23.9	10.6	24.3	
24-26	24.2	25.0	24.1		18.7	15.6	18.8	
27-30	21.4	12.5	21.6		25.7	15.1	26.0	
Sex				.66				.21
Female	61.6	56.3	61.7		50.3	31.7	50.8	
Male	38.4	43.8	38.3		49.7	68.3	49.2	
Race/Ethnicity‡				.01				.10
White, non-Hispanic	64.8	31.3	65.4		55.2	22.3	56.1	
Black, non-Hispanic	10.9	18.8	10.8		14.6	14.8	14.6	
Hispanic	14.2	18.8	14.1		19.7	44.9	19.1	
Other§	10.1	31.3	9.7		10.4	18.1	10.3	
Relationship Status				.27				.43
Single	51.3	37.5	51.6		56.7	42.7	57.1	
In a committed relationship	48.7	62.5	48.4		43.3	57.3	42.9	
Living Situation				.89				.67
With parent/guardian	36.8	31.3	36.9		45.9	33.3	46.2	
With significant other	27.9	31.3	27.9		23.0	23.1	23.0	
Other	35.3	37.5	35.2		31.2	43.6	30.9	
Yearly Household Income				.54				<.001
Low (<\$30,000)	25.0	25.0	25.0		16.3	4.7	16.6	
Medium (\$30,000-\$74,999)	38.1	50.0	37.9		36.0	79.8	34.9	
High (≥\$75,000)	36.8	25.0	37.0		47.6	15.6	48.4	
Education Level				.13				.22
High school or less	28.0	50.0	27.6		45.8	68.5	45.2	
Some college	39.6	31.3	39.7		34.9	16.7	35.4	
Bachelor's degree or higher	32.5	18.8	32.7		19.3	14.8	19.4	
Self-Esteem¶				.36				.15
Low	29.0	18.8	29.2		24.5	9.7	24.9	
High	71.0	81.3	70.8		75.5	90.3	75.1	
Sensation Seeking				.29				.41
Low	33.4	18.8	33.6		31.9	12.7	32.4	
Medium	33.6	31.3	33.6		32.7	42.9	32.4	
High	33.0	50.0	32.7		35.4	44.4	35.2	
Rebelliousness				.20				.46
Low	31.9	25.0	32.0		32.6	35.2	32.5	
Medium	38.4	25.0	38.6		31.8	14.6	32.2	
High	29.7	50.0	29.3		35.6	50.2	35.3	

*Defined as having previously taken at least a puff of an e-cigarette.

†P values were computed using Pearson chi-square tests because all covariates were categorical.

‡Race and ethnic group were self-reported.

§Includes multiracial.

||Defined as not living with a parent/guardian or significant other.

¶Item states "I have high self-esteem," to which participants could respond with increasing levels of agreement.

ratio [AOR], 6.82; 95% confidence interval [CI], 1.65-28.25 (Table 3).

Hispanic ethnicity and high rebelliousness were also significantly associated with this transition (Table 3). In particular, compared with white non-Hispanics, Hispanics had greater odds of cigarette smoking initiation (AOR, 3.13; 95% CI, 1.28-7.63). Compared with those in the lowest tertile, those in the

highest tertile with regard to rebelliousness had greater odds of cigarette smoking initiation (AOR, 4.40; 95% CI, 1.77-10.93). Only those in the oldest age group had lower odds of initiating cigarette smoking. Specifically, compared with those in the 18- to 20-year-old age group, those in the 27- to 30-year-old group had lower odds of cigarette smoking initiation (AOR, 0.31; 95% CI, 0.10-0.95).

Table 2 Characteristics of Study Participants by Initiation of Cigarette Smoking at 18 Months

Characteristics	Initiation of Cigarette Smoking			
	Unweighted		Weighted	
	%	<i>P</i> Value*	%	<i>P</i> Value*
Ever E-Cigarette Use†		<.001		.001
Yes	37.5		47.7	
No	9.0		10.2	
Age, y		.26		.63
18-20	12.6		13.4	
21-23	10.0		11.7	
24-26	7.2		11.3	
27-30	8.2		7.9	
Sex		.28		.60
Female	8.7		10.3	
Male	10.8		12.0	
Race/Ethnicity‡		.01		.01
White, non-Hispanic	7.4		7.8	
Black, non-Hispanic	9.0		8.9	
Hispanic	16.9		21.1	
Other§	13.0		13.7	
Relationship Status		.41		.65
Single	8.7		10.5	
In a committed relationship	10.3		12.0	
Living Situation		.68		.55
With parent/guardian	8.3		9.3	
With significant other	9.8		11.4	
Other	10.3		13.4	
Yearly Household Income		.16		.31
Low (<\$30,000)	12.7		16.3	
Medium (\$30,000-\$74,999)	8.0		9.3	
High (≥\$75,000)	8.9		10.8	
Education Level		.02		.50
High school or less	13.3		13.0	
Some college	9.7		9.9	
Bachelor's degree or higher	6.1		9.1	
Self-Esteem¶		.13		.46
Low	11.7		13.1	
High	8.5		10.6	
Sensation Seeking		.35		.07
Low	7.9		6.5	
Medium	9.2		11.4	
High	11.3		15.1	
Rebelliousness		.001		<.001
Low	6.9		5.5	
Medium	7.2		6.6	
High	15.2		20.5	

**P* values were computed using Pearson chi-square tests because all covariates were categorical.

†Defined as having taken even a puff of an e-cigarette at baseline.

‡Race and ethnic group were self-reported.

§Includes multiracial.

||Defined as not living with a parent/guardian or significant other.

¶Item states "I have high self-esteem," to which participants could respond with increasing levels of agreement.

All multivariable results between unweighted and weighted data were similar in terms of significance and magnitude of odds ratios. Therefore, only weighted results, which are more externally generalizable, are presented in this article.

DISCUSSION

In this longitudinal study among nonsmoking young US adults, baseline e-cigarettes use was strongly and independently associated with cigarette smoking initiation within 18 months. These results raise concerns that adults who initiate nicotine use through e-cigarettes are at increased risk for later use of cigarettes.

The incidence of smoking initiation among e-cigarette users and nonusers in our study (47.7% and 10.2%, respectively) was higher than in previous longitudinal studies. In the Los Angeles study, the incidence rates were 30.7% and 8.1% among e-cigarette users and nonusers, respectively.²⁷ In the Hawaii study, the incidence rates were 19.5% and 5.4%, respectively.²⁹ Finally, in a cohort of adolescents and some young adults, cigarette initiation was 37.5% and 9.6% among initial e-cigarette users and nonusers, respectively.²⁸ Our estimates may have been higher because we used an 18-month follow up, whereas all 3 of those studies used a follow-up of 6 to 12 months. Also, those studies involved younger populations. Our results are consistent with studies showing young adulthood to be an important time of consolidation of tobacco-use behaviors.⁴⁵

In our study, it is notable that initiation of cigarette smoking among baseline e-cigarette users was so high—47.7% in the weighted data—even among young adults with a median age of 23 years. This is surprising because prior studies suggest that approximately 90% of cigarette smokers began before they were 18 years of age⁴⁶ and that the average age of first cigarette is between 11 and 13 years.³ Because we only included people who had never smoked before, they were presumably highly resilient to cigarette smoking. Nevertheless, initiation was high among e-cigarette users. This suggests that clinicians who encounter e-cigarette-only users should counsel them about the high rate of transition, even if those patients had not previously smoked cigarettes.

It may seem unlikely that e-cigarette users may transition from a flavored, highly palatable device such as an e-cigarette to a more noxious, unflavored cigarette. However, there are several reasons why individuals who try e-cigarettes may be at risk for this transition, even if they do not intend on smoking cigarettes at first. One reason is that many e-cigarettes—particularly early-generation devices—provide nicotine more slowly than traditional cigarettes.⁴⁷ Thus, they may serve as an ideal transition vehicle, allowing a new user to advance to cigarette smoking as tolerance to side effects develops. Just as new cigarette users begin to report craving for nicotine within weeks of their first cigarette,⁴⁸ initial e-cigarette users may soon begin to seek out cigarettes as a more efficient nicotine delivery device. E-cigarettes also mimic many powerful behavioral cues of cigarette smoking, including inhalation, exhalation, and holding the implement. For example, people exposed to e-cigarette advertising report more craving for smoking cigarettes.¹³ Initial exposure to nicotine in other forms—such as smokeless tobacco—can lead to later traditional cigarette smoking.⁴⁹ Thus, one might expect susceptibility to be even greater when the presence of nicotine is augmented by strong behavioral cues of cigarette

Table 3 Unadjusted and Adjusted Associations Between Baseline Characteristics and Initiation of Cigarette Smoking at 18 Months

Characteristics	Initiation of Cigarette Smoking	
	OR (95% CI)	AOR* (95% CI)
Ever E-Cigarette Use†		
No	1 [Reference]	1 [Reference]
Yes	7.98 (1.87-34.1)	6.82 (1.65-28.25)
Age, y		
18-20	1 [Reference]	1 [Reference]
21-23	0.86 (0.39-1.86)	0.86 (0.37-2.01)
24-26	0.83 (0.31-2.19)	0.67 (0.19-2.44)
27-30	0.55 (0.21-1.44)	0.31 (0.10-0.95)
Sex		
Female	1 [Reference]	1 [Reference]
Male	1.19 (0.62-2.27)	1.09 (0.54-2.20)
Race/Ethnicity‡		
White, non-Hispanic	1 [Reference]	1 [Reference]
Black, non-Hispanic	1.17 (0.42-3.26)	1.36 (0.44-4.19)
Hispanic	3.18 (1.44-7.05)	3.13 (1.28-7.63)
Other§	1.88 (0.74-4.76)	1.82 (0.74-4.50)
Relationship Status		
Single	1 [Reference]	1 [Reference]
In a committed relationship	1.16 (0.61-2.21)	1.25 (0.57-2.73)
Living Situation		
With parent/guardian	1 [Reference]	1 [Reference]
With significant other	1.26 (0.55-2.91)	2.77 (0.85-9.01)
Other	1.51 (0.70-3.24)	1.77 (0.79-3.97)
Yearly Household Income		
Low (<\$30,000)	1 [Reference]	1 [Reference]
Medium (\$30,000-\$74,999)	0.52 (0.24-1.15)	0.45 (0.19-1.06)
High (≥\$75,000)	0.62 (0.29-1.36)	0.82 (0.33-2.01)
Education Level		
High school or less	1 [Reference]	1 [Reference]
Some college	0.73 (0.35-1.50)	0.75 (0.35-1.60)
Bachelor's degree or higher	0.67 (0.30-1.50)	1.03 (0.32-3.26)
Self-Esteem¶		
Low	1 [Reference]	1 [Reference]
High	0.79 (0.41-1.50)	0.53 (0.28-1.01)
Sensation Seeking		
Low	1 [Reference]	1 [Reference]
Medium	1.86 (0.84-4.12)	1.28 (0.59-2.77)
High	2.58 (1.22-5.44)	1.20 (0.47-3.05)
Rebelliousness		
Low	1 [Reference]	1 [Reference]
Medium	1.21 (0.55-2.67)	1.26 (0.52-3.04)
High	4.41 (2.08-9.38)	4.40 (1.77-10.93)

AOR = adjusted odds ratio; CI = confidence interval; OR = odds ratio.

*Adjusted for all variables in the table.

†Defined as having taken even a puff of an e-cigarette at baseline.

‡Race and ethnic group were self-reported.

§Includes multiracial.

||Defined as not living with a parent/guardian or significant other.

¶Item states "I have high self-esteem," to which participants could respond with increasing levels of agreement.

smoking. Finally, initial e-cigarette users also may transition to traditional cigarettes because of changing social pressures over time. For example, although most initial alcohol users favor sweet, sugary beverages, many ultimately transition to harsher and more concentrated forms. Future qualitative research among e-cigarette users may be particularly

valuable for identifying whether this situation may be somewhat analogous for the transition from e-cigarettes to cigarettes.

However, it should also be noted that finding a longitudinal association does not necessarily imply causality. For example, it is possible that the individuals who initiated

cigarette smoking ultimately would have begun smoking anyway, whether or not they used e-cigarettes in the interim. This seems unlikely, because this sample consisted of people who had not begun cigarette smoking during the usual times of risk for this behavior.^{3,46} Additionally, we controlled in our multivariable analyses for factors such as sensation seeking and rebelliousness that often predict later cigarette smoking. However, future research should examine additional criteria for causality, because the finding of a longitudinal association is only one such criterion.⁵⁰

Unadjusted and AORs for the association between e-cigarette and later uptake of combustible cigarettes were similar (7.98 and 6.82). Additionally, there were no significant 2-way interactions between e-cigarette use and each covariate. Taken together, these facts suggest that concerns around e-cigarettes should not be limited to specific subpopulations.

These findings have implications for policy related to alternative tobacco products. Federal regulation is in process, and certain municipalities and states have begun to include e-cigarettes in clean air laws.¹⁷ However, e-cigarettes are still not subject to many regulations designed to limit cigarette smoking, such as restriction of flavorings, restrictions on marketing, taxation, and labeling requirements.^{15,51,52} These policy gaps may increase accessibility of e-cigarettes to nonsmokers.⁵ For example, e-cigarettes are marketed on television, representing the first time in more than 40 years that a smoking-related device is advertised on this medium. This may have the unintended consequence of renormalizing cigarette smoking after decades of public health efforts shifted public norms around smoking.^{53,54} Therefore, these results may be important for the Food and Drug Administration to consider as it debates a proposed rule determining how specifically to exercise their authority over e-cigarettes.^{55,56}

Limitations

It is important to note that there were only a small number of e-cigarette smokers at baseline (~2.5% in the weighted sample), which limited our statistical power and resulted in wide CIs. However, it is notable that, despite this low power, we found consistently significant results. One reason for the small number may be that the baseline data were collected in 2013, and e-cigarette use has increased substantially even since then.⁵⁷ Therefore, it would be valuable to examine patterns such as these in the future. It should also be emphasized that our outcome variable was initiation of smoking and not a more distal outcome such as frequent smoking, daily smoking, or established smoking. However, initiation of smoking is known to be a crucial step in the trajectory to these later and more clinically problematic outcomes.³⁷ Still, it will be particularly important for future research to examine other outcomes.

Limitations of the sample should be noted. For example, the follow-up was only approximately 60%, and weighting cannot control for all potential biases. Although this was unlikely to change results substantially because there were no

demographic differences between those retained and those not retained, this remains a potentially important consideration.

CONCLUSIONS

Our nationally representative study identified a longitudinal association between baseline e-cigarette use and subsequent initiation of cigarette smoking among young adults. Although this is consistent with other emerging evidence, it is particularly noteworthy that these findings apply to adults and not only youth.

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