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Initiation of Traditional Cigarette Smoking after Electronic Cigarette Use Among Tobacco-Naïve U.S. Young Adults

Brian A. Primack, MD, PhD[a,b,c], **Ariel Shensa, MA**[a,b], **Jaime E. Sidani, PhD**[a,b], **Beth L. Hoffman, BSc**[a,b], **Samir Soneji, PhD**[d,e], **James D. Sargent, MD**[d,e,f], **Robert Hoffman, MD**[g], **Michael J. Fine, MD, MSc**[a,b,g]

[a]Division of General Internal Medicine, Department of Medicine, University of Pittsburgh School of Medicine, Pittsburgh, PA, USA

[b]Center for Research on Media, Technology, and Health, University of Pittsburgh School of Medicine, Pittsburgh, PA, USA

[c]Division of Adolescent Medicine, Department of Pediatrics, University of Pittsburgh School of Medicine, Pittsburgh, PA, USA

[d]Norris Cotton Cancer Center, Geisel School of Medicine, Dartmouth University, Hanover, NH, USA

[e]Dartmouth Institute for Health Policy & Clinical Practice, Geisel School of Medicine at Dartmouth, Hanover, NH, USA

[f]Department of Pediatrics, Geisel School of Medicine, Dartmouth University, Hanover, NH, USA

[g]VA Pittsburgh Healthcare System, Pittsburgh, PA, USA

Abstract

Background.—While 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 U.S. population to recruit a nationally-representative sample of never-smoking young adults ages 18–30. 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 non-responders. After applying survey weights—which accounted for both non-response and over

Corresponding Author: Brian A. Primack, MD, PhD, 230 McKee Place, Suite 600, Pittsburgh, PA 15213, bprimack@pitt.edu, 412-586-9789 (phone); 412-692-4838 (fax).

or under coverage—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 non-users (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 non-smokers.

Keywords

Electronic nicotine delivery devices; nicotine; priority/special populations; harm reduction

INTRODUCTION

Electronic cigarette (e-cigarette) use is increasing among youth and young adults.[1–5] For example, in 2014 prevalence of past 30-day e-cigarette use (13.4%) was higher than 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; while 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 non-smokers. E-cigarettes may seem to be an attractive alternative to traditional cigarette smoking among non-smokers because they are flavored, more palatable to consume, and perceived as safe.[13–16] While the U.S. 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 (versus non-users) 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 in order to extend 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 socio-demographic, personal, and environmental characteristics.

METHODS

Participants

We collected baseline and follow-up data on participants recruited from a nationally-representative probability-based online non-volunteer access panel recruited and maintained by Growth from Knowledge (GfK). 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 U.S. 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, non-institutionalized English-speaking adults 18–30 years old 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 re-assess 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 NIH. 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 socio-demographic, personal, and environmental covariates that have been independently associated with initiation of cigarette smoking.[28,30,35,37,38]

Socio-demographic Variables.: GfK provided data on participant age, sex, race and ethnicity, and education level. We divided age into four categories based on data distribution: 18–20, 21–23, 24–36, and 27–30 years. We categorized self-reported race and ethnicity as White, 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 α=0.79).[40] We assessed rebelliousness using a 3-item validated Likert-type subscale of Smith and Fogg that included items such as "I tend to go against the rules" (Cronbach's α=0.79).[41]

Environmental Variables.: We categorized yearly household income as low (under $30,000), medium ($30,000 to $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, 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 that results could be more easily interpreted. However, we also conducted sensitivity analyses operationalizing all covariates as continuous in order to assure 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 χ^2 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 two-way interactions between the independent variable and each covariate, and none of these interaction terms was 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 non-response, as well as non-coverage, under-, or over-sampling resulting from the sample design. For all analyses, we defined statistical significance with a two-tailed α of 0.05. Data were analyzed using Stata 12.[44]

We conducted three sets of sensitivity analyses to explore the robustness of our findings. First, we modeled all covariates that could possibly be continuous (e.g., 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 here.

RESULTS

Sample of Participants

The initial survey was open to GfK's complete sample of 6420 individuals ages 18–30 at the time of the survey. Enrollment was stopped after 3254 consented. This included 1,506 young adults who had never smoked cigarettes, who represented the baseline sample for the current study. Of those baseline non-smokers, 915 (60.8%) completed follow-up and were included in our analyses. Respondents and non-respondents at follow-up were no different in terms of age ($P = 0.38$), sex ($P = 0.36$), or race/ethnicity ($P = 0.20$). Additionally, any slight non-significant differences were accounted for in the survey weighting (please see Statistical Analyses above). The unweighted sample was 61.6% female, 64.8% white, 10.9% black, 14.2% Hispanic, and had a median age of 23 years (IQR 20 – 26). The weighted sample was 50.3% female, 55.2% white, 14.6% black, 19.7% Hispanic, and had a median age of 23 years (IQR 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 non-users, 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 to 81 (9.0%) of 899 e-cigarette non-users ($P < .001$) (Table 2). After applying sampling weights, cigarette smoking was initiated in 47.7% of e-cigarette users and 10.2% of non- users 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 non-e-cigarette smokers, baseline e-cigarette smokers had greater odds of initiating cigarette smoking (AOR = 6.82, 95% 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 18–20-year-old age group, those in the 27–30 year-old group had lower odds of cigarette smoking initiation (AOR=0.31, 95% CI=0.10–0.95).

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 here.

DISCUSSION

In this longitudinal study among non-smoking young U.S. 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 non-users in our study (47.7% and 10.2%, respectively) was higher than previous longitudinal studies. In the Los Angeles study, the incidence rates were 30.7% and 8.1% among e-cigarette users and non-users, respectively.[27] In the Hawaii study, the incidence rates were 19.5% and 5.4%.[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 non-users, respectively.[28] Our estimates may have been higher because we used an 18-month follow up, while all three of those studies used a follow-up of 6–12 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. This is surprising because prior studies suggest that about 90% of cigarette smokers began before they were 18[46] and that the average age of first cigarette is between 11 and 13.[3] Because we only included people who had never smoked before, they were presumably highly resilient to cigarette smoking. Nevertheless, initiation was quite 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 smoking. Finally, initial e-cigarette users also may transition to traditional cigarettes because of changing social pressures over time. For example, while 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 adjusted odds ratios for the association between e-cigarette and later uptake of combustible cigarettes were very similar (7.98 and 6.82). Additionally, there were no significant two-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 non-smokers.[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 (about 2.5% in the weighted sample), which limited our statistical power and resulted in wide confidence intervals. 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 also be noted. For example, the follow-up was only about 60%, and weighting cannot control for all potential biases. While 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.

Conclusion

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

ACKNOWLEDGMENTS

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Table 1.

Characteristics of Study Participants (Unweighted and Weighted) by E-cigarette Use at Baseline

	Unweighted Data				Weighted Data			
	E-cigarette Use at Baseline*				E-cigarette Use at Baseline*			
	All	Yes	No		All	Yes	No	
Characteristics	n = 915	n = 16	n = 899	P Value†	n = 32,040,393	n = 801,010	n = 31,239,383	P Value†
Age, years				.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 (under $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 or more)	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	

	Unweighted Data				Weighted Data			
	E-cigarette Use at Baseline[*]				E-cigarette Use at Baseline[*]			
	All	**Yes**	**No**		**All**	**Yes**	**No**	
Characteristics	**n = 915**	**n = 16**	**n = 899**	**P Value**[†]	**n = 32,040,393**	**n = 801,010**	**n = 31,239,383**	**P Value**[†]
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 X^2 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.

Table 2.

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

| Characteristics | Initiation of Cigarette Smoking | | | |
| | Unweighted | | Weighted | |
	%	P Value*	%	P 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 (under $30,000)	12.7		16.3	
Medium ($30,000–74,999)	8.0		9.3	
High ($75,000 or more)	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

| Characteristics | Initiation of Cigarette Smoking | | | |
| | Unweighted | | Weighted | |
	%	P Value[*]	%	P Value[*]
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 X^2 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.

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 (under $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 or more)	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]

| Characteristics | Initiation of Cigarette Smoking | |
	OR (95% CI)	AOR* (95% CI)
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)**

Abbreviations: OR, odds ratio; CI, confidence interval; AOR, adjusted 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.