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Electronic Cigarette Use and Uptake of Cigarette Smoking: A Longitudinal Examination of U.S. College Students

Tory R. Spindle, MS[1,4], **Marzena M. Hiler, MS**[1,4], **Megan Cooke, BS**[2], **Thomas Eissenberg, PhD**[1,4], **Kenneth S. Kendler, MD**[5], and **Danielle Dick, PhD**[3,4,6,7]

[1]Center for the Study of Tobacco Products, Virginia Commonwealth University, Richmond, VA

[2]Virginia Institute for Psychiatric and Behavioral Genetics, Virginia Commonwealth University, Richmond, VA

[3]Department of African American Studies, Virginia Commonwealth University, Richmond, VA

[4]Department of Psychology, Virginia Commonwealth University, Richmond, VA

[5]Department of Psychiatry, Virginia Commonwealth University, Richmond, VA

[6]Department of Human and Molecular Genetics, Virginia Commonwealth University, Richmond, VA

[7]College Behavioral and Emotional Health Institute (COBE), Virginia Commonwealth University, Richmond, VA

Abstract

Introduction—Electronic cigarette (e-cigarette) use prevalence is increasing among U.S. adolescents and adults but recent longitudinal data for college/university students are scarce. Furthermore, the extent that e-cigarette use is associated with the onset of cigarette smoking and the factors that lead to the uptake of e-cigarettes in college students has not been explored.

Correspondence should be addressed to: Tory Spindle: spindletr@vcu.edu, Doctoral Candidate, Department of Psychology, Virginia Commonwealth University, PO Box 980205, Richmond, VA 23298, or Danielle M. Dick: ddick@vcu.edu, Professor, Department of Psychology, Virginia Commonwealth University, 816 West Franklin Street, PO Box 842509, Richmond, VA 23284.

Contributors: Authors Tory Spindle, Marzena Hiler, and Megan Cooke conducted statistical analyses and literature searches and completed the first draft of the manuscript. Danielle Dick and Kenneth Kendler designed the Spit for Science study protocol and are current CO-PI's on the project. Danielle Dick, Kenneth Kendler, and Thomas Eissenberg also contributed to the final draft of the manuscript by providing comments and feedback.

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Methods—3,757 participants from a Mid-Atlantic university (women: 66%; White: 45%; Black: 21%; Asian: 19%; Hispanic/Latino: 6%) were surveyed in 2014 and again in 2015.

Results—Among participants reporting never smoking at time 1, those who had ever tried e-cigarettes or were currently using e-cigarettes (at least one use in past 30 days) were more likely to have ever tried cigarettes by time 2 relative to individuals who had not used e-cigarettes. Ever use of e-cigarettes (but not current use) also increased participants' likelihood of being current cigarette smokers at time 2. Among initial never users of e-cigarettes or cigarettes, males and ever marijuana users had an increased probability of trying e-cigarettes by time 2. Furthermore, less perseverance (an index of impulsivity) and ever use of other tobacco products increased initial never users' chances of trying both cigarettes and e-cigarettes by time 2.

Conclusions—Given that never-smoking participants who had tried e-cigarettes were more likely to initiate cigarette use later, limiting young adults' access to these products may be beneficial. As the long-term health implications of e-cigarette use become clearer, predictors of e-cigarette use could help identify future populations likely to use and abuse these products.

Keywords

electronic cigarettes; tobacco cigarettes; longitudinal tobacco use; college/university students

1. INTRODUCTION

Electronic cigarettes (e-cigarettes) are a class of tobacco products that use a heating element to aerosolize a liquid, often containing nicotine, for user inhalation. Despite limited research regarding the health effects associated with acute and long term use of e-cigarettes, these products are rapidly growing in popularity among adolescents (e.g., middle and high school students; Bunnell et al., 2015) and adults (King, Alam, Promoff, Arrazola, & Dube, 2013; McMillen, Gottlieb, Shaefer, Winickoff, & Klein, 2014). However, longitudinal use patterns of e-cigarettes are not well understood among college/university students.

Examining e-cigarette use in college populations is important for several reasons. First, approximately half of young adults in the U.S. attend a college or university (U.S. Census Bureau, 2014) and according to the limited data available, e-cigarette use is increasing among college students (Littlefield, Gottlieb, Cohen, & Trotter, 2015; Pearson, Richardson, Niaura, Vallone, & Abrams, 2012; Regan, Pronnoff, Dube, Arrazola, & 2013; Sutfin, Reboussin, Debinski, Wagoner, Spangler, & Wolfson, 2015). Second, college students historically have been at the forefront of substance use trends that ultimately become more prevalent in broader populations (Johnston, O'Malley, Bachman, Schulenberg 2008), suggesting that the characteristics of college e-cigarette users of today could be indicative of who may be most likely to use these products in the future. Third, e-cigarettes have become more widely available and accessible nationwide (Lee & Kim, 2014), particularly in retail outlets near college campuses (Wagoner et al., 2014). Lastly, although several longitudinal studies using high school students (Barrington-Trimis et al., 2016; Leventhal et al., 2015; Wills, Knight, Sargent, Gibbons, Pagano, & Williams, 2016), one using Hispanic young adults (Unger, Soto, & Leventhal, 2016), and one using an adolescent and young adult sample (Primack et al., 2015) have demonstrated that e-cigarette use is predictive of

initiating cigarette smoking, no such studies have examined this association in a large, diverse sample of college students. Given the numerous public health ramifications of e-cigarette use leading to later onset of cigarette smoking (the current leading preventable cause of death in the U.S.; USDHHS, 2014), longitudinal studies are important for informing appropriate regulations for these products. That is, if young adults who use e-cigarettes are in fact more likely to transition to cigarette smoking, accessibility to e-cigarettes may need to be reduced in these populations, possibly by increasing the minimum purchasing age for tobacco products (including e-cigarettes) to 21, as Hawaii and California have already done (Aliferis, 2016).

A better understanding of the factors that are associated with initiation of e-cigarette use may also inform e-cigarette regulation. However, factors predictive of the onset of e-cigarette use are not well understood, despite being examined extensively for conventional cigarettes and other substances. For example, the extent to which numerous factors associated with the uptake of conventional tobacco products such as anxiety and depression (McKenzie, Olsson, Jorm, Romaniuk, & Patton, 2010; Patton, Carlin, Coffey, Wolfe, Hibbert, and Bowes, 1998), peer deviance (Brook, Whiteman, Czeisler, Shapiro, & Cohen, 1997), stressful life events (Byrne, Byrne, & Reinhart, 1995), and impulsivity (Mitchell, 1999) also predict the uptake of e-cigarette use has not been explored thoroughly.

The present study examined the extent to which e-cigarette use among never cigarette smokers at time 1 of the study was predictive of cigarette smoking status at time 2 (one year later), while controlling for other relevant variables that independently may predict the uptake of cigarettes. A secondary purpose of this study was to examine if several factors previously predictive of the onset of cigarette smoking (anxiety, depression, peer deviance, stressful life events, impulsivity, and the use of other tobacco products and marijuana) predicted the onset of e-cigarette use among initial never users of either cigarettes or e-cigarettes.

2. METHODS

2.1 Participants

The sample for the current study was a subset of the Spit for Science (S4S) project, a university-wide longitudinal study aimed at assessing genetic and environmental influences on substance use and emotional health in college students (Dick et al., 2014). This study was approved by the Institutional Review Board (IRB) at Virginia Commonwealth University (VCU). Starting in the fall of 2011, all freshmen aged 18 and older were invited to participate in the S4S project by filling out an online survey. Approximately 70% of incoming freshman have participated in the S4S study each year since its inception. Prior to taking this survey, participants were provided with an explanation of the study and provided informed consent online. Participants were then invited to complete a follow-up survey each subsequent year. E-cigarette questions were first added to the survey in 2014 and re-administered again in 2015; accordingly, responses provided in 2014 served as “time 1” while responses provided in 2015 served as “time 2” for all the present analyses. 5,779 participants responded in 2014 (time 1) while 4,748 participants provided responses in 2015 (time 2). This study includes all participants who responded to the survey at both time points

(total N = 3,757; 62% female, mean age = 18.5; SD = 0.43). The ethnic breakdown was as follows: White: 47%; Black: 19%; Asian: 17%; Hispanic/Latino: 6%, mixed race/ethnicity: 7%. The remaining 4% of participants reported being either: American Indian/Alaskan Native, Native Hawaiian/Other Pacific Islander, unknown race or ethnicity, or chose not to answer the question. Overall, the final sample in the present study was representative of the current gender and racial/ethnic makeup of the general student body (~24,000 undergraduates) at VCU: female: 57%; White: 48%; Black: 19%; Asian: 14%; Hispanic/Latino: 8%, mixed race/ethnicity: 5%.

2.2 Measures

Described below are items that participants responded to online at both time points addressing demographic information, tobacco/nicotine product use, marijuana use, and several factors previously associated with cigarette smoking including anxiety, depression, peer deviance, stressful life events, and impulsivity (Dick et al., 2014).

2.3 Tobacco Product and Marijuana Use

Participants were asked how many e-cigarettes they had used in their lifetime (“None”, “1–9”, “10–99”, “100–200”, or “200 or more”) and during the last 30 days on how many days they used e-cigarettes (“I didn’t use e-cigarettes in the past month”, “Once or twice”, “A few days”, “A couple of days a week”, “Three times a week”, and “Daily or almost daily”). Items addressing other tobacco products (i.e., cigarettes, smokeless tobacco, little cigars/cigarillos, and hookah) were formatted similarly. Participants were also asked whether they had ever used marijuana (“yes” or “no”).

2.4 Other Factors Previously Associated with Cigarette Smoking

Anxiety and depression were each measured using subsets of four items from the Symptom Checklist (SCL)-90 (Derogatis, Lipman, & Covi, 1973) that measures symptoms of anxiety (i.e., “feeling fearful,” “suddenly scared for no reason,” “nervousness or shakiness inside,” “spells of terror or panic”) or depression (i.e., “feeling blue,” “worrying too much about things,” “feeling hopeless about the future,” “feeling no interest in things”) within the last 30 days on a five-point Likert scale. Participants rated how much each symptom caused them discomfort with response options ranging from “Not at all” (1) to “Extremely” (5). Peer deviance was measured by six items addressing how many of the student’s friends (from “none” to “all”) had smoked cigarettes, drank alcohol, gotten drunk, had problems with alcohol, been in trouble with the law, and smoked marijuana. Stressful life events were measured by 12 items (Kendler, Karkowski, & Prescott, 1998) addressing whether the student had experienced a potentially stressful life event in the past 12 months (e.g., “separation from loved one or close friend,” “serious illness or injury,” experiencing physical or sexual assault”). Each endorsement of a stressful life event was summed to create an overall score (as in Cooke, Nasim, Cho, Kendler, Clark, & Dick 2016). The impulsivity subscales including: lack of perseverance, lack of premeditation, negative urgency, positive urgency, and sensation seeking were assessed using three items from the UPPS-P Impulsive Behavior Scale (Carlson, Pritchard, & Dominelli, 2013). Each of these items was measured on a four point Likert scale. Example items from these subscales include: lack of perseverance (“I finish what I start”), lack of premeditation (“I usually think

carefully before doing anything"), negative urgency ("when I am upset, I often act without thinking"), positive urgency ("I tend to act without thinking when I am really excited"), and sensation seeking ("I quite enjoy taking risks").

2.5 Data Preparation and Analyses

Study data were collected and managed using REDCap (Research Electronic Data Capture) electronic data capture tools. REDCap is a secure, web-based application designed to support data capture for research studies, providing (1) an interface for validated data entry, (2) audit trails for tracking data manipulation and export procedures, (3) export procedures for data downloads to common statistical packages, and (4) procedures for importing data from external sources (Harris, Taylor, Thielke, Payne, Gonzalez, & Conde, 2009).

Two sets of cross classification comparisons were conducted in order to examine overall e-cigarette/cigarette use patterns across the two time points. The first set of these cross classification analyses compared time 1 and time 2 e-cigarette/cigarette ever-use groups (i.e., never users, ever users of e-cigarettes only, ever users of cigarettes only, and ever users of e-cigarettes and cigarettes). The second set of analyses compared time 1 e-cigarette/cigarette ever-use groups with time 2 e-cigarette/cigarette current use groups (i.e., current exclusive e-cigarette users, current exclusive cigarette smokers, and current dual users of e-cigarettes and cigarettes). In the second cross classification analysis, the time 2 ever use categories were also included, as this provided more accurate percentages of individuals who transitioned into the various e-cigarette/cigarette current use groups.

For all logistic regression analyses, ever use and past 30 day use items were changed from the original formatting to a dichotomous "yes" or "no" outcome. Thus, participants were considered to have ever used cigarettes/e-cigarettes if they had used these products on even one occasion and were considered current users if they had used these products at least once in the past 30 days. Two multivariate logistic regressions were conducted to examine whether e-cigarette use status (i.e., ever e-cigarette use only or current exclusive e-cigarette use) among never-smokers at time 1 predicted onset of cigarette smoking at time 2. Demographic characteristics, the use of other nicotine-containing products, and other variables previously shown to independently predict the uptake of cigarette smoking (e.g., impulsivity) were included as covariates. For all analyses using race/ethnicity as a covariate, white participants were used as the reference group as this was the most common race/ethnicity in the sample. For each continuous covariate, independent samples t-tests were conducted in order to examine whether participants who only provided responses at time 1 differed from those who provided responses at both time points. Those who provided answers for the first time point only reported significantly greater time 1 levels of peer deviance (Mean = 8.91; SD = 5.04) relative to those who provided answers for both time points (Mean = 8.49; SD = 4.97). The additional continuous covariates (depression, anxiety, negative urgency, positive urgency, lack of premeditation, lack of perseverance, sensation seeking) did not differ between those who responded at time 1 only and those who responded at both time points. Person correlations (r) were conducted between all covariates in order to assess multicollinearity. The greatest correlation coefficient observed between covariates was for anxiety and depression (r = .68) followed by negative urgency and

positive urgency (r = .51), lack of premeditation and lack of perseverance (r = .44), and lack of premeditation and positive urgency (r = .37). Overall, all Pearson correlation coefficients fell well below the commonly used cutoff of .8 for detecting collinearity (Berry & Feldman, 1985; Mason & Perreault, 1991), and thus all covariates were included in the regression models.

A multivariate multinomial logistic regression was conducted to determine whether several time 1 factors previously predictive of the onset of cigarette smoking (i.e., anxiety, depression, peer deviance, stressful life events, impulsivity, and the use of other tobacco products/marijuana) predicted the initiation of e-cigarette use at time 2. This multinomial regression included only those who originally reported never using either e-cigarettes or cigarettes and also modeled the likelihood of uptake of cigarettes-only and dual use (i.e., ever use of e-cigarettes and cigarettes).

3. RESULTS

3.1 Overview/Cross Classification Analysis

Among those who initially identified as never users of either e-cigarettes or cigarettes (total = 2,163), 7.1% initiated cigarette smoking, 5.7% initiated e-cigarette use, and 3.5% initiated use of both e-cigarettes and cigarettes at time 2. Alternatively, among those who reported ever only trying e-cigarettes at time 1 (total = 153), 24.2% reported having tried cigarettes at time 2. Finally, 29.3% of individuals who initially had only ever tried cigarettes (total = 651) reported uptake of e-cigarettes at time 2 (Table 1).

For individuals initially identifying as never users of either e-cigarettes or cigarettes, 0.8% became current exclusive cigarette smokers, 1.5% transitioned to current exclusive e-cigarette users, and 0.4% reported being current dual users at time 2. Conversely, among those who reported only ever using e-cigarettes at time 1 (total = 153), 7.2% reported current cigarette use at time 2 (5.2% current exclusive cigarette smokers and 2.0% current dual users). Finally, 7.1% of individuals who initially had only ever used cigarettes (total = 651) reported current e-cigarette use at time 2 (3.1% current exclusive e-cigarette users and 4.0% current dual users; Table 2).

3.2 Predicting Uptake of Cigarettes Among Initial Never Smokers

Two multivariate logistic regressions were conducted to determine whether e-cigarette use status at time 1 (ever and current) among never cigarette smokers was predictive of cigarette use status (no/yes for ever and no/yes for current cigarette use) at time 2 (Table 3). For these analyses, gender, age, race/ethnicity, impulsivity (all five subscales), depression/anxiety, stressful life events, peer deviance, and ever use of other tobacco products were included as covariates. When controlling for these covariates, never smokers who had tried e-cigarettes at time 1were significantly more likely to have reported ever trying cigarettes at time 2. In a similar vein, past 30 day use of e-cigarettes among those who initially reported never smoking cigarettes at time 1 was predictive of ever use of cigarettes at time 2. The Nagelkerke pseudo R^2 suggested that the complete model (with all covariates included) accounted for approximately 6.5% of the total variance in cigarette initiation at time 2. As a

point of comparison, removing all covariates except for time 1 e-cigarette use status, age, gender, and race/ethnicity accounted for approximately 4.9% (i.e., Nagelkerke pseudo R^2 = .049) of the total variance in cigarette initiation at time 2 . Thus, the other covariates included in the complete model (impulsivity subscales, depression/anxiety, stressful life events, peer deviance, and ever use of other tobacco products) collectively accounted for only about 1.6% of the variance in time 2 ever cigarette use among these initial never smokers.

Furthermore, ever e-cigarette use (but not current e-cigarette use) at time 1 among never cigarette smokers increased the likelihood that these individuals would be currently using cigarettes at time 2 (Table 3). The lack of association between time 1 current e-cigarette use and time 2 current cigarette smoking should be interpreted with caution, as the wide confidence interval for this adjusted odds ratio indicates that this group was very small. Indeed only six initial nonsmokers transitioned from a time 1 current e-cigarette user into a current cigarette smoker at time 2. The Nagelkerke pseudo R^2 for this logistic regression suggested that the complete model (with all covariates included) accounted for approximately 7.3% of the total variance in current cigarette use at time 2 among these initial never smokers. In comparison, removing all covariates except for time 1 e-cigarette use status, age, gender, race/ethnicity accounted for approximately 6.6% (i.e., Nagelkerke pseudo R^2 = .066) of the total variance in current cigarette use at time 2 among these individuals.

Three covariates independently predicted cigarette use at time 2 (race/ethnicity, stressful life events, and lack of perseverance: one of the subscales of impulsivity). Specifically, relative to the reference group of white participants, Asian and Black/African American initial non-smokers were less likely to report ever and current cigarette use at time 2 while Hispanic initial non-smokers were more likely to have ever used cigarettes by the second time point. In addition, individuals reporting higher amounts of stressful life events and more lack of perseverance were more likely to report having tried cigarettes by time 2. Lastly, males had a higher likelihood of transitioning into current cigarette smokers relative to females.

3.3 Initial Never Users Transitioning to E-cigarette/Cigarette Use

A multinomial multivariate logistic regression using only participants who initially reported never having used e-cigarettes or cigarettes found that several factors measured at time 1 were predictive of these individuals transitioning to having used e-cigarettes by time 2 (Table 4). For example, initial never users were more likely to transition to ever using only e-cigarettes if they were male, or if they had ever tried marijuana. Several variables were also predictive of trying only cigarettes or trying both e-cigarettes and cigarettes by time 2 among initial never users of either product. Hispanic individuals (relative to the reference group of White participants) and those reporting greater amounts of stressful life events had a greater likelihood of trying only cigarettes by time 2. In addition, participants who identified as male, had ever used other tobacco products aside from e-cigarettes or cigarettes at time 1, and had higher initial scores on the lack of perseverance scale were more likely to transition to ever-dual users at time 2. Finally, Black/African American time 1 never users were less likely than the reference group to transition to ever-dual users at time 2.

4. DISCUSSION

The primary purpose of these longitudinal analyses were to examine the relationship between e-cigarette use at time 1 and the uptake of cigarette smoking at time 2 while controlling for numerous covariates previously demonstrated to be predictive of cigarette smoking. Results demonstrated that initial never smokers who had ever used or were currently using e-cigarettes had a greater probability of having tried cigarettes by time 2. Furthermore, ever use of e-cigarettes at time 1 increased initial never cigarette smokers' chances of reporting current cigarette use at time 2. However, current e-cigarette use at time 1 did not make initial never smokers more likely to transition to current cigarette smokers at time 2 (although this null finding should be interpreted with caution, as a very small number of initial never smokers who were current e-cigarette users transitioned to current cigarette smokers at time 2). While other longitudinal studies have demonstrated that e-cigarette use is predictive of the uptake of cigarettes in adolescent populations (Leventhal et al., 2015; Wills et al., 2016), the present study is the first to demonstrate this effect in a sample of young adults (18 years or older) attending a university.

Importantly, the possibility exists that some individuals in the present study were inevitably going to use cigarettes and may have begun using e-cigarettes first due to reasons that were not examined (although recent findings that e-cigarettes can facilitate smoking among low-risk adolescents challenges this assumption; Barrington-Trimis et al., 2016; Wills, Sargent, Gibbons, Pagano, & Schweitzer, 2016). Despite this possibility, we speculate that the observed associations between e-cigarette use and the later use of cigarettes could be suggestive of several other things. The finding that e-cigarette use among initial never smokers resulted in later use of cigarettes may suggest that e-cigarettes can be reinforcing to some individuals as a result of delivering nicotine and/or providing certain sensory stimuli, thus serving as a catalyst to trying other tobacco products that are reinforcing in a similar manner (e.g., tobacco cigarettes). However, given that the majority of initial non-smokers who had used e-cigarettes did not later initiate cigarette smoking, the extent to which factors that reinforce tobacco use were the causal mechanism through which exclusive e-cigarette users began smoking cigarettes in this study is unclear. Ultimately, more longitudinal research studies conducted over the course of several years, involving a variety of populations, and with careful consideration of the types of devices and liquids individuals are using are necessary to determine unequivocally whether e-cigarette use serves as a catalyst for the uptake of cigarette smoking.

Another purpose of this study was to determine whether several factors that influence the uptake of cigarettes such as anxiety, depression, peer deviance, stressful life events, and impulsivity were predictive of the onset of e-cigarette use among initial never users of either cigarettes or e-cigarettes. As in previous studies examining the uptake of cigarette smoking, results from the present study demonstrated that those identifying as male were more likely to have initiated e-cigarette use by time 2. In addition, individuals who had ever tried marijuana had a greater probability of having used e-cigarettes by the second time point. Also similar to previous studies examining the uptake of cigarettes, greater impulsivity levels (on one of the five impulsivity scales: lack of perseverance; Mitchell, 1999) and the use of other tobacco products aside from e-cigarettes and cigarettes (i.e., little cigars/

cigarillos, smokeless tobacco, waterpipe; Cooke et al. 2016) independently resulted in an increased probability of initiating the use of both e-cigarettes and cigarettes by time 2.

Conversely, several other factors that typically are predictive of the uptake of cigarettes did not influence the uptake of e-cigarettes in the present study. The initiation of e-cigarette use largely was not predicted by externalizing (e.g., sensation seeking) or internalizing (e.g., depression, anxiety) factors: the two primary causal mechanisms through which individuals begin using tobacco cigarettes and other substances (Byrne et al., 1995; Hussong, Jones, Stein, Baucom, Boeding, 2011; McKenzie et al., 2010). Thus, some individuals may begin using e-cigarettes through alternative pathways not examined in the present study that are unique to e-cigarettes. For example, exposure to e-cigarette marketing has increased generally (e.g., celebrity endorsements and television commercials) and advertising of e-cigarettes is associated positively with appeal and intention to use e-cigarettes in college students (Trumbo & Kim, 2015). Furthermore, individuals holding favorable views regarding the harms associated with e-cigarettes may be more likely to use these products (Wills et al., 2016). Continued research exploring the causal mechanisms through which individuals begin using e-cigarettes is important, as additional pathways to use independent of internalizing and externalizing dimensions may exist that have not been characterized.

There were several limitations to the present study. First, the sample was limited to a single university in one geographic area. Thus, these results may not be generalizable to college students in other parts of the country. However, the present study contained a rather large and diverse sample relative to other examinations of e-cigarette use using college/university samples (Littlefield et al., 2015) and the use rates of other substances (e.g., cigarettes, alcohol, marijuana, other illicit drugs) in this dataset have been very comparable to national surveys that did not examine e-cigarette use (Johnston et al., 2008; Knight, Wechsler, Kuo, Seibring, Weitzman, Schuckit, 2002). Second, several covariates used in this study did not predict the onset of e-cigarette/cigarette. Future examinations may benefit from the inclusion of additional covariates not measured in this study that may independently predict e-cigarette and/or cigarette initiation (e.g., harm perceptions, exposure to advertising). Third, the questions administered in this survey did not differentiate between different e-cigarette models and liquids, of which there are thousands available on the market currently (Zhu et al., 2015). Importantly, different device/liquid characteristics can have a profound influence on users' nicotine delivery, subjective effects, and presumably, a user's level of nicotine dependence (Farsalinos et al., 2014; Ramôa et al., 2015; Lechner et al., 2015). Assessing the use rates of different models of e-cigarettes (e.g., fixed vs adjustable power) and e-cigarette liquids may help determine whether certain device/liquid combinations increase an individual's likelihood of transitioning to using other nicotine-containing products (such as tobacco cigarettes) more than others. Lastly, some individuals who identified initially as a smoker and/or an e-cigarette user reported being a never user at follow-up. Recanting is commonplace in longitudinal studies, particularly those with adolescent and young adult samples, and may occur due to a variety of reasons (e.g., social desirability, recall bias; Fendrich, & Rosenbaum, 2003). Given the large sample size of the present study, the relatively small percentage (~3 %) of participants who recanted their cigarette and/or e-cigarette use status likely did not affect the overall results. Despite these limitations, the

present study provides much needed current data concerning college/university e-cigarette use that are scarce at this time.

In conclusion, the present study demonstrated that both ever and current e-cigarette use increased non-smokers' probability of having tried cigarettes one year after initial data collection occurred. Furthermore, ever e-cigarette use increased non-smokers' chances of reporting current cigarette use at time 2 of the study. However, current e-cigarette use did not make initial non-smokers' more likely to transition to currently smoking cigarettes at the second study time point. In addition, the uptake of e-cigarettes was influenced by some factors that previously have been demonstrated to be predictive of the use of tobacco cigarettes (e.g., gender, race/ethnicity). However, numerous other established risk factors for the uptake of cigarettes (e.g., depression, stressful life events, peer deviance) did not predict e-cigarette initiation in the present study. Additional information concerning the extent to which e-cigarette use serves as a starter product to using other nicotine-containing products (e.g., Blank & Eissenberg, 2015; Cobb, Hendricks, & Eissenberg, 2015) and predictors of e-cigarette use will be important when considering future regulations of these products, including their accessibility to various adolescent and young adult populations.

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Highlights

- E-cig and cigarette use has not been studied in college students longitudinally.
- Ever and current e-cig use increased non-smokers chances of trying cigarettes.
- Historically internalizing/externalizing factors predict cigarette uptake strongly.
- Most internalizing/externalizing factors examined did not predict e-cig uptake.
- Males and marijuana users were more likely to initiate e-cig use.

Table 1

Results of Cross Classification Comparison of Time 1 and Time 2 E-cigarette/Cigarette Ever-Use Categories.

		Time 2 E-cigarette/Cigarette Ever-Use Status				
		Never Users	**Cigarette-only**	**Ecig-only**	**Dual Users**	**Total**
Time 1 E-cigarette/Cigarette Ever-Use Status	Never Users	1810 (83.7%)	154 (7.1%)	123 (5.7%)	76 (3.5%)	2163
	Cigarette-only	53 (8.1%)	399 (61.3%)	8 (1.2%)	191 (29.3%)	651
	Ecig-only	37 (24.2%)	8 (5.2%)	71 (46.4%)	37 (24.2%)	153
	Dual Users	27 (3.9%)	75 (10.9%)	13 (1.9%)	575 (83.3%)	690
	Total	1927	636	215	879	3657

Table 2

Results of Cross Classification Comparison of Time 1 E-cigarette/Cigarette Ever-Use Categories with Time 2 E-cigarette/Cigarette Current-Use Categories.

		Never Users	Current Cigarette-only	Current Ecig-only	Current Dual Users	Total
Time 1 E-cigarette/Cigarette Ever-Use Status	Never Users	1810 (83.7%)	18 (0.8%)	32 (1.5%)	9 (0.4%)	2163
	Ever Cigarette-only	53 (8.1%)	77 (11.8%)	20 (3.1%)	26 (4.0%)	651
	Ever Ecig-only	37 (24.2%)	8 (5.2%)	20 (13.1%)	3 (2.0%)	153
	Ever Dual Users	27 (3.9%)	206 (29.7%)	45 (6.5%)	159 (22.9%)	690
	Total	1927	309	117	197	3657

Note. This cross classification comparison also included the time 2 ever use categories depicted in Table 1.

Table 3

Adjusted Odds Ratios and CI's (95%) of Time 1 Factors Predicting Time 2 Cigarette Use Status (Including only never smokers at T1).

Time 1 Never Smokers	**Ever Cigarette Use (Time 2)**	**Current Cigarette Use (Time 2)**
Ever E-cigarette Use	3.37 (1.91 – 5.94)*	3.30 (1.20 – 9.05)*
Current E-cigarette Use Covariates	3.41 (1.57 – 7.41)*	1.15 (0.15 – 9.06)
Demographics		
Gender	1.31 (0.93 – 1.84)	1.96 (1.07 – 3.61)*
Age	1.06 (0.71 – 1.59)	1.36 (0.66 – 2.81)
Asian	0.62 (0.40 – 0.97)*	0.35 (0.14 – 0.86)*
Black/African American	0.65 (0.43 – 0.98)*	0.28 (0.10 – 0.73)*
Hispanic	2.10 (1.21 – 3.64)*	1.10 (0.37 – 3.25)
Mixed Race	1.15 (0.62 – 2.16)	0.52 (0.12 – 2.24)
Psychological Characteristics		
Depression	1.02 (0.96 – 1.08)	0.98 (0.88 – 1.10)
Anxiety	0.96 (0.89 – 1.03)	1.02 (0.90 – 1.16)
Impulsivity		
Negative Urgency	0.90 (0.70 – 1.17)	0.99 (0.61 – 1.60)
Positive Urgency	1.04 (0.79 – 1.36)	0.84 (0.50 – 1.41)
Lack of premeditation	0.90 (0.66 – 1.21)	1.00 (0.57 – 1.79)
Lack of perseverance	1.52 (1.11 – 2.07)*	1.21 (0.66 – 2.23)
Sensation Seeking	1.05 (0.83 – 1.33)	1.30 (0.81 – 2.08)
Other		
Stressful life events	1.07 (1.01 – 1.15)*	1.07 (0.93 – 1.23)
Peer deviance	1.00 (0.96 – 1.03)	0.99 (0.92 – 1.06)
Other Tobacco Use	1.06 (0.72 – 1.57)	0.87 (0.39 – 1.93)

Note: Asterisks (*) indicate a significant odds ratio ($p < .05$).

Table 4

Adjusted Odds Ratios and CI's (95%) of Time 1 Factors Predicting Time 2 Nicotine Ever-Use Group (Including only never users at T1).

	Time 2 Use Category Contrast		
Characteristics (Time 1)	**C vs N (Time 2)**	**EC v N (Time 2)**	**DU v N (Time 2)**
Demographics			
Gender	1.24 (0.79 – 1.94)	2.03 (1.30 – 3.16)*	2.32 (1.29 – 4.18)*
Age	1.17 (0.72 – 1.91)	0.99 (0.55 – 1.78)	0.89 (0.42 – 1.88)
Asian	0.56 (0.31 – 1.03)	0.67 (0.37 – 1.21)	0.95 (0.47 – 1.92)
Black/AA	0.80 (0.48 – 1.33)	0.87 (0.52 – 1.47)	0.41 (0.17 – 0.99)*
Hispanic	2.83 (1.47 – 5.45)*	0.72 (0.25 – 2.12)	1.93 (0.69 – 5.43)
Mixed Race	1.36 (0.61 – 3.04)	1.38 (0.61 – 3.12)	1.14 (0.33 – 3.98)
Psychological Characteristics			
Depression	0.99 (0.92 – 1.06)	0.97 (0.89 – 1.05)	1.06 (0.96 1.17)
Anxiety	0.94 (0.85 – 1.03)	1.04 (0.95 – 1.14)	1.01 (0.90 – 1.13)
Impulsivity			
Negative Urgency	0.89 (0.64 – 1.22)	1.08 (0.77 – 1.51)	1.00 (0.64 – 1.55)
Positive Urgency	0.97 (0.69 – 1.37)	0.90 (0.63 – 1.31)	0.97 (0.60 – 1.55)
Lack of premeditation	1.07 (0.73 – 1.56)	0.99 (0.65 – 1.49)	0.73 (0.42 – 1.25)
Lack of perseverance	1.23 (0.83 – 1.82)	1.19 (0.78 – 1.81)	1.99 (1.15 – 3.44)*
Sensation Seeking	1.01 (0.75 – 1.37)	1.07 (0.77 – 1.49)	1.22 (0.78 – 1.89)
Other			
Stressful life events	1.11 (1.02 – 1.22)*	1.02 (0.92 – 1.13)	1.09 (0.96 – 1.230)
Peer deviance	1.02 (0.97 – 1.07)	1.02 (0.97 – 1.08)	0.97 (0.90 – 1.04)
Other Tobacco use	0.96 (0.56 – 1.63)	0.99 (0.58 – 1.68)	2.18 (1.07 – 4.45)*
Ever Marijuana use	0.99 (0.60 – 1.63)	1.88 (1.12 – 3.13)*	0.67 (0.32 – 1.43)

Note: N= never users (reference group); EC = E-cigarette-only; C= Cigarette-only; DU = Dual Users. Asterisks (*) indicate a significant odds ratio ($p < .05$).