Published in final edited form as:

Health Educ Behav. 2018 August ; 45(4): 532–539. doi:10.1177/1090198117739672.

Examining College Students' Social Environment, Normative Beliefs, and Attitudes in Subsequent Initiation of Electronic Nicotine Delivery Systems

Deepti Agarwal, MSSW, MA¹, Alexandra Loukas, PhD¹, and Cheryl L. Perry, PhD²

¹The University of Texas at Austin, Austin, TX, USA

²The University of Texas Health Science Center at Houston (UTHealth), Austin, TX, USA

Abstract

Background.—Although use of Electronic Nicotine Delivery Systems (ENDS) is increasingly prevalent among young adults, little is known about predictors of ENDS initiation among this population.

Aims.—We examined the roles of the social environment (i.e., peer ENDS use and household ENDS use), normative beliefs (i.e., social acceptability of ENDS use), and attitudes (i.e., inclination to date someone who uses ENDS) in prospectively predicting initiation of ENDS over a 1-year period among 18- to 29-year-old college students.

Method.—Participants were 2,110 (18- to 29-year-old) students ($M = 20.27$, $SD = 2.17$) from 24 colleges in Texas who participated in a three-wave online survey, with 6 months between each wave. All participants reported never using ENDS at baseline. A multivariable, multilevel logistic regression model, accounting for clustering of students within colleges, was used to assess if students' social environment, normative beliefs, and attitudes predicted subsequent initiation of ENDS up to 1 year later, adjusting for various sociodemographic factors and number of other tobacco products used.

Results.—In all, 329 college students (16%) initiated ENDS within 1 year. Results from the logistic regression indicated that college students who were younger (18–24 years old), ever used other tobacco products, indicated a more dense peer network of ENDS users, and had a higher inclination to date someone who uses ENDS had higher odds of initiating ENDS than their peers.

Conclusion.—Preventing ENDS initiation should be included in college health promotion programs, which should highlight the roles of students' social environment and attitudes regarding ENDS use.

Impact Statement.

Reprints and permissions: sagepub.com/journalsPermissions.nav

Corresponding Author: Alexandra Loukas, Department of Kinesiology & Health Education, The University of Texas at Austin, 2109 San Jacinto Boulevard, D3700, Austin, TX 78712, USA. alexandra.loukas@austin.utexas.edu.

Authors' Note

The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health or the U.S. Food & Drug Administration.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Tobacco prevention programs on college campuses should include Electronic Nicotine Delivery Systems (ENDS) as part of a comprehensive tobacco control effort to prevent the use of all types of tobacco products. In particular, college prevention programs should leverage the use of peers to denormalize ENDS use, especially among younger college students (18–24 years old) and those who use other tobacco products. Moreover, communication campaigns should educate college students about the potential harms and lack of evidence regarding the long-term health consequences of ENDS use, including the possibilities that ENDS use may lead to nicotine addiction and/or to the use of combustible tobacco products.

Keywords

electronic cigarettes; college students; tobacco control

Introduction

Use of ENDS, also referred to as e-cigarettes, is increasing at alarming rates (King, Patel, Nguyen, & Dube, 2015), and prevalence is even higher than that of cigarettes among young populations (Arrazola et al., 2015). ENDS use is concerning because these products contain potential toxicants (Department of Health & Human Services, Food & Drug Administration, Center for Drug Evaluation and Research, Division of Pharmaceutical Analysis, 2009; Farsalinos, Kistler, Gillman, & Voudris, 2015) and often contain nicotine that is addictive (Etter, Zäther, & Svensson, 2013). Nicotine also negatively affects brain development, which is concerning because the human brain continues to develop into young adulthood (Yuan, Cross, Loughlin, & Leslie, 2015). Among adults, ENDS use is highest among young adults (18–24 year olds), with 14.2% reporting current use and 21% reporting ever use in 2013 (McMillen, Gottlieb, Shaefer, Winickoff, & Klein, 2015). A large proportion of young adults (almost 40%) are also college students (U.S. Department of Education, National Center for Education Statistics, 2014), and current research shows that college students' ENDS use is high, with 15% reporting current use and 30% reporting ever use in one study (Saddleson et al., 2015).

College students may be particularly likely to use ENDS because this population is open to trying new and novel products (Johnston, O'Malley, Bachman, & Schulenberg, 2010), finds ENDS products innovative (Trumbo & Harper, 2013), and is targeted by the tobacco industry (Ling & Glantz, 2002). Moreover, the college years are characterized by changes in various developmental domains and behaviors (Arnett, 2005), including social relationships, living arrangements, normative beliefs, dating behaviors (Arnett, 2005), and tobacco use (White, Bray, Fleming, & Catalano, 2009). Thus, tobacco products are initiated and regular use patterns are formed during this period (White et al., 2009). Yet we know very little about the initiation of ENDS during the college years and the factors contributing to initiation.

College students are nested in social environments that include their peers or close friends, and those with whom they live, including peers and family members. According to social cognitive theory (SCT; Bandura, 1986), social environments provide opportunities to communicate with others and observe their behaviors and their consequences, which in turn

foster learning of those behaviors. From this perspective, ENDS use can be learned in interaction with other students and family members (Bandura, 1986). Consistent with SCT (Bandura, 1986), evidence indicates that college students' initiation and overall use of tobacco is greatly influenced by their peers and family (Kong, Morean, Cavallo, Camenga, & Krishnan-Sarin, 2015; Richter, Caraballo, Gupta, & Pederson, 2008). There is further evidence that college students have been offered ENDS by peers and family (Kong et al., 2015) and tried noncigarette tobacco products, such as hookah, cigars, smokeless tobacco, bidis, and *kreteks* because people in their social environments used these products (Richter et al., 2008). Moreover, research on adolescents indicates that peer and family ENDS use is positively associated with ENDS use (Barrington-Trimis et al., 2015). However, we know little about the role of peer and household ENDS use in predicting ENDS initiation among college students.

The theory of reasoned action (TRA) also emphasizes the role of valued others in determining individuals' behaviors (Fishbein & Ajzen, 1975). In particular, TRA indicates that normative beliefs or the evaluation and acceptance of behaviors by other people are important determinants of behaviors (Fishbein, & Ajzen, 1975), such as ENDS use. This theory also indicates that individuals' own attitudes or their personal evaluations concerning a behavior determine that behavior (Fishbein, & Ajzen, 1975). Normative beliefs are reflected in college students' social acceptability (Sidani, Shensa, Barnett, Cook, & Primack, 2014) of ENDS use and their attitudes toward ENDS use can be captured by their inclination to date someone who uses ENDS (Arnett, 2005). Existing evidence indicates that college students generally have more favorable attitudes towards and higher acceptance of ENDS use than traditional cigarette use (Noland et al., 2016). Moreover, research on adolescents indicates that higher social acceptability of peers' ENDS use contributes to greater likelihood of ENDS use (Barrington-Trimis et al., 2015). However, the roles of social acceptability of ENDS use and inclination to date someone who uses ENDS in predicting ENDS initiation in college students are unknown.

In summary, we know little about the initiation of ENDS during the college years. The purpose of the present study was to examine the role of the social environment, normative beliefs, and attitudes in predicting subsequent ENDS initiation across a 1-year period among 18- to 29-year-old college students. Based on prior research and on SCT and TRA, we hypothesized that a denser environment of peer ENDS users, denser household ENDS use, higher social acceptability of ENDS use, and higher inclination to date someone who uses ENDS, all assessed at baseline, would each uniquely predict greater odds of subsequent ENDS initiation up to 1 year later, even after controlling for various sociodemographic factors and other tobacco use.

Method

Participants

Participants were 2,110 18- to 29-year-old college students drawn from the first three waves of the Marketing and Promotions Across Colleges in Texas project (Project M-PACT), which collected data every 6 months from November 2014 to February 2015 from a cohort of 5,482 college students. Because the goal of this study was to examine ENDS initiation,

only participants who indicated never using ENDS at baseline and who also had complete data on the study variables at Waves 2 and 3 ($n = 2,110$) were included in the present study. Participants were 18 to 29 years old ($M = 20.27$; $SD = 2.17$) at baseline and more than half were women (66.4%). Regarding race/ethnicity, 35.4% of students were non-Hispanic White, 26.9% were Hispanic/Latino, 7.7% were African American/Black, 23.3% were Asian, and 6.8% reported other race/ethnicity or reported two or more races/ethnicities.

Procedure

Participants were recruited from 24 2- and 4-year colleges located in five counties surrounding four Texas cities (Austin, Dallas/Ft. Worth, Houston, San Antonio). Eligible students received e-mail invitations, which described the purpose of the study and included a link to an eligibility survey (see Loukas et al., 2016, for additional details). More than 13,000 students ($n = 13,714$) were eligible to participate in the study, and of these, 40% ($n = 5,482$) provided consent and completed the survey.

Measures

Ever ENDS Use.—Initiation of ENDS was assessed at all three waves as ever ENDS use. Ever ENDS use was modeled after an item developed by the Population Assessment of Tobacco and Health (PATH) study (National Institutes of Health, 2015). Students were asked, “Have you ever used an ENDS product, (i.e., e-cigarette, vape pen, or e-hookah) as intended (i.e., with nicotine cartridges)?” Only participants who answered “No” to this question at Wave 1 (never users of ENDS) were included in the present study. Subsequently, participants were classified as ever ENDS users/ENDS initiators (coded as 1) if they answered “Yes” to the question at either Wave 2 or Wave 3 and never ENDS users (coded as 0) if they answered “No” to the question at both waves.

Peer ENDS Use.—Peer ENDS use was assessed at Wave 1 using an item adapted from PATH (National Institutes of Health, 2015) and the Youth Tobacco Survey (Starr et al., 2005), by asking, “How many of your close friends use ENDS products?” Responses to the item were coded 0 = *none* to 4 = *all*. Higher scores reflect a denser environment of peer ENDS users.

Household ENDS Use.—Household ENDS use was assessed at Wave 1 using an item adapted from the PATH (National Institutes of Health, 2015) study, by asking, “Does anyone you live with now use ENDS products?” Response options were 1 = *yes*, 2 = *no*, 3 = *I don’t know*, 4 = *N/A—I live alone*. Participants who responded *yes*, *no*, or *N/A—I live alone* were included in the analyses. *Yes* was recoded as 1 and *no* and *N/A—I live alone* were recoded as 0. Participants who indicated *I don’t know* ($n = 70$) were not included in any analyses.

Social Acceptability of ENDS Use.—Social acceptability of ENDS use was assessed at Wave 1 using an item adapted from the PATH (National Institutes of Health, 2015) study by asking, “How socially acceptable is it for people your age to use ENDS products?” Response options ranged from 1 = *totally unacceptable* to 5 = *totally acceptable*. Higher scores reflect more favorable attitudes toward social acceptability of ENDS use.

Inclination to Date Someone Who Uses ENDS.—Inclination to date someone who uses ENDS was assessed at Wave 1 using an item adapted from the Monitoring the Future study (National Institute on Drug Abuse, 2004). Students were asked to respond to the item, “I would date someone who uses ENDS products,” on a scale ranging from 1 = *strongly disagree* to 5 = *strongly agree*. Higher scores reflect higher inclination to date someone who uses ENDS.

Sociodemographic and Other Tobacco Use Covariates.—Younger college students, males, White students, and users of other tobacco products are more likely to use ENDS compared to their counterparts (Agaku et al., 2014; Higgins et al., 2015; Sutfin et al., 2015; Sutfin, McCoy, Morrell, Hoepfner, & Wolfson, 2013), and there are differences in tobacco use between students enrolled in 2-year and 4-year colleges (Loukas, Murphy, & Gottlieb, 2008). To control for these differences, age, gender, race/ethnicity, school enrollment (2-year versus 4-year), and number of other tobacco products used (all assessed at Wave 1) were included as covariates in the study model. Dummy variables were created for race/ethnicity (Hispanic/Latino, African American/Black, Asian, Other) with non-Hispanic White students as the reference group. Ever use of other tobacco products, including cigarettes, hookah, smokeless tobacco and cigars, was assessed at Wave 1 for each of the four products (coded as 0 = *never used*, 1 = *used at least once*). The number of tobacco products participants ever used at Wave 1 was summed, so that scores for ever use of other tobacco products for each participant ranged from 0 to 4.

Attrition Analysis

Given the purpose of the study, only data from college students who indicated never using ENDS at baseline ($n = 2,846$) were considered for inclusion in analyses. Of the 2,846 never ENDS users, data from 664 were excluded from the present study because they did not participate in either Wave 2 or Wave 3, and therefore we were unable to ascertain their ENDS use status subsequent to baseline. Data from an additional 72 students were excluded because they were missing data on the variables of interest for this study. The final sample thus consisted of 2,110 college students. Attrition analyses were conducted to examine differences between college students who were successfully followed up and had complete data ($n = 2,110$) and those who were lost either due to attrition or missing data ($n = 736$) on all Wave 1 study variables, using Pearson chi-square tests and t tests. Students who were not included in the present study ($n = 736$) were significantly more likely than those who were included ($n = 2,110$) to be enrolled in a 2-year college, $\chi^2(1) = 8.01, p < .05$, to identify as Hispanic/Latino, $\chi^2(1) = 7.27, p < .05$, and African American/Black, $\chi^2(1) = 11.01, p < .05$, use more “other” tobacco products, $t(2,844) = 4.97, p < .05$, and were significantly less likely to identify as Asian, $\chi^2(1) = 26.97, p < .001$. There were no differences between the two groups on any other Wave 1 study variables.

Data Analysis

Data analyses were conducted in two stages using STATA Version 14. First, unadjusted multilevel logistic regression models, accounting for the clustering of students within the 24 colleges, were used to examine bivariate associations between the four social environment, normative beliefs, and attitudes variables at baseline and subsequent initiation of ENDS

across the 1-year period. The four baseline variables served as independent variables, and each was evaluated in separate multilevel models without adjusting for any covariates. The dependent variable was the dichotomous initiation of ENDS variable (i.e., never used ENDS vs. initiated ENDS at Wave 2 or Wave 3). Next, a multivariable, multilevel logistic regression model was used to assess the unique associations between the four baseline variables and subsequent ENDS initiation, after accounting for the covariates. The independent variables for this model included peer ENDS use, household ENDS use, social acceptability of ENDS use, inclination to date someone who uses ENDS, and the sociodemographic and other tobacco use covariates. The multivariable model accounted for the clustering of students within the 24 colleges, and the dependent variable was the dichotomous initiation of ENDS variable.

Results

At baseline, all college student participants were never users of ENDS ($n = 2,110$). After 1 year, 15.6% ($n = 329$) of college students indicated initiating ENDS, 10% ($n = 201$) initiated at Wave 2 and 6% ($n = 128$) initiated at Wave 3. Of the 329 initiators, 27% ($n = 90$) did not use any other tobacco product at baseline. Chi-square analyses examining baseline sociodemographic characteristics indicated that males and Hispanics/ Latinos were significantly more likely and Asians were significantly less likely than their counterparts to initiate ENDS by Wave 3. However, there were no other significant associations between the other sociodemographic characteristics (Wave 1 age, and enrollment in 4-year vs. 2-year college) and ENDS initiation by Wave 3 (see Table 1).

Unadjusted multilevel logistic regression analyses examining the bivariate associations indicated that all four study variables (peer ENDS use, household ENDS use, social acceptability of ENDS use, inclination to date someone who uses ENDS) predicted greater odds of subsequent initiation of ENDS (see Table 2). Results from the adjusted multivariable, multilevel logistic regression analysis indicated that among the covariates, only Wave 1 age and number of other tobacco products ever used predicted subsequent ENDS initiation (see Table 3). Younger college students (18–24 year olds) and those reporting a greater number of other tobacco products ever used had greater odds of reporting subsequent initiation compared with their peers. Among the social environment, normative beliefs, and attitude variables, only peer ENDS use and inclination to date someone who uses ENDS uniquely predicted increased odds of subsequent ENDS initiation, after accounting for all covariates (see Table 3). Thus, compared to their counterparts, participants who had more peers who used ENDS and who reported a greater inclination to date someone who used ENDS had higher odds of initiating ENDS up to a year later.

Discussion

The present study extends existing research by examining the roles of the social environment, normative beliefs, and attitudes in prospectively predicting college students' ENDS initiation. Consistent with limited prior research indicating that alternative tobacco products are initiated during young adulthood (Rath, Villanti, Abrams, & Vallone, 2012) almost 16% ($n = 329$) of college students (who had never tried ENDS at baseline) initiated

ENDS use within a 1-year period. Moreover, more than a quarter of initiators ($n = 90$) had no history of other tobacco use, underscoring the public health concern that nicotine-naïve young adults are using ENDS (Sutfin et al., 2013) and that ENDS use may introduce nicotine-naïve youth to combustible tobacco products, such as cigarettes (Krishnan-Sarin, Morean, Camenga, Cavallo, & Kong, 2015). The results of this study also partially support SCT (Bandura, 1986) and TRA (Fishbein & Ajzen, 1975), indicating that even after accounting for sociodemographic factors and ever use of other tobacco products, peer ENDS use and inclination to date someone who uses ENDS were unique predictors of subsequent ENDS initiation. Findings highlight the importance of targeting college students' peers and attitudes in approaches to prevent ENDS use.

Young adults observe and model peer cigarette smoking behaviors (Harakeh & Vollebergh, 2013) so that cigarette smoking by even one peer in their social environment increases the likelihood of cigarette smoking among young adults (Harakeh & Vollebergh, 2013). Consistent with SCT (Bandura, 1986), research on cigarettes, as well as qualitative and cross-sectional evidence on young adults' and adolescents' ENDS use (Sutfin et al., 2015; Richter et al., 2008; Barrington-Trimis et al., 2015), a denser peer ENDS use environment uniquely predicted subsequent ENDS initiation. The social environment therefore remains an important determinant of ENDS use during young adulthood and the college years. Given that the college environment facilitates peer interactions and opportunities to model peer behaviors including ENDS use, campus-based tobacco control efforts must consider the role of peers in preventing and limiting ENDS use. Tobacco control efforts should leverage support of college students' peers to denormalize ENDS use. Peer-led strategies have been useful in denormalizing conventional tobacco use on college campuses (Morrison & Talbott, 2005).

Findings also indicated that compared with their peers, students who reported a higher inclination to date someone who uses ENDS were more likely to subsequently use ENDS. Findings are in agreement with TRA (Fishbein & Ajzen, 1975), and research on adolescents showing that dating someone who smokes cigarettes is associated with increased likelihood of smoking cigarettes (Mermelstein, Colvin, & Klingemann, 2009). College students' dating behaviors are a reflection of their personal attitudes (Arnett, 2005), which are important determinants of health behaviors according to TRA (Fishbein & Ajzen, 1975). Favorable attitudes toward ENDS is concerning because the long-term health consequences of using these products have not been firmly established (Grana, Benowitz, & Glantz, 2014), and there is ambiguity in the contents of ENDS (Cheng, 2014) as well as the presence of toxicants (Farsalinos et al., 2015). Although the Food & Drug Administration (2016) recently finalized a rule extending its authority over ENDS products, regulations requiring health warnings on products and the disclosure of constituents are not yet fully implemented. Therefore, college students' knowledge regarding these products' safety and constituents not only are likely inadequate (Sanders-Jackson, Tan, Bigman, & Henriksen, 2015) but also may contribute to their favorable attitudes toward ENDS. Thus, educating college students about the potential harms regarding the long-term health consequences of ENDS use (Grana et al., 2014), including the possibilities that ENDS use may lead to nicotine addiction and/or to the use of combustible tobacco products (Krishnan-Sarin et al.,

2015; Sutfin et al., 2013), may be another strategy for limiting ENDS initiation among college students.

Contrary to expectations and SCT (Bandura, 1986) and TRA (Fishbein & Ajzen, 1975), college students' household ENDS use and social acceptability of ENDS use were not unique predictors of ENDS initiation. Lack of association between household ENDS use and ENDS initiation may be because college students may be living with individuals who are not valued or important in their lives (e.g., dormitory roommates). Rather, as the results demonstrate, close peers may be a better predictor of ENDS initiation and a better measure of college students' social environment than household ENDS use. The lack of association between social acceptability and ENDS initiation may be because ENDS are already relatively socially acceptable (compared to cigarettes) among college students including nonusers (Noland et al., 2016), and therefore social acceptability does not distinguish between ENDS initiators and noninitiators. Further research examining the roles of household ENDS use and normative beliefs about ENDS initiation is nonetheless warranted.

Strengths and Limitations

To our knowledge, this is the first study to examine the role of social environment, normative beliefs, and attitudes in predicting subsequent ENDS initiation among college students. The study's foremost strengths are the large and diverse sample of college students (derived from 24 colleges, 4-year as well as 2-year), and its prospective design, which allows determination of temporal precedence between social environment, normative beliefs, and attitudes in predicting subsequent ENDS initiation. Nonetheless, there are some limitations. First, the findings cannot be generalized to other college students outside of Texas or to 18- to 29-year-olds who are not in college. Second, there was differential attrition, such that students enrolled in 2-year colleges, those who identified as Hispanic/Latino or African American/Black and used more "other" tobacco products were more likely than their peers to be lost due to attrition. Caution is thus warranted in generalizing findings. However, given that tobacco users are more likely than nonusers to also use ENDS (Sutfin et al., 2015), the finding that more "other" tobacco users were lost to attrition suggests that we may be underestimating ENDS initiation, and in turn the strength of association between the predictors and subsequent ENDS use. Future studies should replicate findings with broader, nationally representative samples. Although there are transitions in cigarette smoking behaviors among young adults, with some transitioning from initiation of tobacco use to regular use (White et al., 2009), the present study was limited to examination of ENDS initiation only and thus some participants may be experimental users who do not transition to regular use of ENDS. Subsequent research examining predictors of transitions to regular use is needed. Finally, ENDS are a diverse and growing class of products (Grana et al., 2014), and although they were treated as a homogeneous class in the present study, there may be differences in factors predicting use of different device types, which should be explored in future research.

Implications

Tobacco prevention programs on college campuses should include ENDS as part of comprehensive tobacco control efforts to prevent the use of all types of tobacco products.

College prevention programs should also leverage the use of peers (Morrison & Talbott, 2005) to denormalize ENDS use especially among younger college students, and those who use other tobacco products. Moreover, communication campaigns should educate college students about the potential harms and lack of evidence regarding the long-term health consequences of ENDS use, including the possibilities that ENDS use may lead to nicotine addiction and/or to the use of combustible tobacco products (Etter et al., 2013; Krishnan-Sarin et al., 2015).

Acknowledgments

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the Tobacco Center of Regulatory Science on Youth and Young Adults (1 P50 CA180906) from the National Cancer Institute at the National Institutes of Health and the Food & Drug Administration Center for Tobacco Products.

References

- Agaku IT, King BA, Husten CG, Bunnell R, Ambrose BK, & Hu SS, ... Centers for Disease Control and Prevention. (2014). Tobacco product use among adults—United States, 2012–2013. *Morbidity and Mortality Weekly Report*, 63(25), 542–547. [PubMed: 24964880]
- Arnett JJ (2005). The developmental context of substance use in emerging adulthood. *Journal of Drug Issues*, 35, 235–254. doi:10.1177/002204260503500202.
- Arrazola RA, Singh T, Corey CG, Husten CG, Neff LJ, & Apelberg BJ, ... Centers for Disease Control and Prevention. (2015). Tobacco use among middle and high school students—United States, 2011–2014. *Morbidity and Mortality Weekly Report*, 64(14), 381–385. [PubMed: 25879896]
- Bandura A (1986). *Social foundations of thought and action: A social cognitive theory* Englewood Cliffs, NJ: Prentice Hall.
- Barrington-Trimis JL, Berhane K, Unger JB, Cruz TB, Huh J, Leventhal AM, ... McConnell R (2015). Psychosocial factors associated with adolescent electronic cigarette and cigarette use. *Pediatrics*, 136, 308–317. doi:10.1542/peds.2015-0639 [PubMed: 26216326]
- Cheng T (2014). Chemical evaluation of electronic cigarettes (FDA E-cigarettes: Impact on individual and population health). *Tobacco Control*, 23(Suppl.2), II11 Retrieved from http://tobaccocontrol.bmj.com/content/23/suppl_2/ii11 [PubMed: 24732157]
- Department of Health & Human Services, Food & Drug Administration, Center for Drug Evaluation and Research, Division of Pharmaceutical Analysis. (2009). *Evaluation of e-cigarettes* Washington, DC: Food and Drug Administration Retrieved from <http://www.fda.gov/downloads/drugs/Scienceresearch/UCM173250.pdf>
- Etter J, Zäther E, & Svensson S (2013). Analysis of refill liquids for electronic cigarettes. *Addiction*, 108, 1671–1679. doi:10.1111/add.12235 [PubMed: 23701634]
- Farsalinos KE, Kistler KA, Gillman G, & Voudris V (2015). Evaluation of electronic cigarette liquids and aerosol for the presence of selected inhalation toxins. *Nicotine & Tobacco Research*, 17, 168–174. doi:10.1093/ntr/ntu176 [PubMed: 25180080]
- Fishbein M, & Ajzen I (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research* Reading, MA: Addison-Wesley.
- Food & Drug Administration. (2016). The facts on the FDA's new tobacco rule Retrieved from <http://www.fda.gov/downloads/ForConsumers/ConsumerUpdates/UCM507132.pdf>
- Grana R, Benowitz N, & Glantz SA (2014). E-cigarettes: A scientific review. *Circulation*, 129, 1972–1986. doi:10.1161/CIRCULATIONAHA.114.007667. [PubMed: 24821826]
- Harakeh Z, & Vollebergh WAM (2013). Young adult smoking in peer groups: An experimental observational study. *Nicotine & Tobacco Research*, 15, 656–661. doi:10.1093/ntr/nts183 [PubMed: 22965788]

- Higgins ST, Kurti AN, Redner R, White TJ, Gaalema DE, Roberts ME, ... Atwood GS (2015). A literature review on prevalence of gender differences and intersections with other vulnerabilities to tobacco use in the United States, 2004–2014. *Preventive Medicine*, 80, 89–100. doi:10.1016/j.ypmed.2015.06.009 [PubMed: 26123717]
- Johnston LD, O'Malley PM, Bachman JG, & Schulenberg JE (2010). Monitoring the Future (MTF): National survey results on drug use, 1975–2010: College students and adults ages 19–50 Retrieved from <http://files.eric.ed.gov/fulltext/ED528082.pdf>
- King BA, Patel R, Nguyen KH, & Dube SR (2015). Trends in awareness and use of electronic cigarettes among US adults, 2010–2013. *Nicotine & Tobacco Research*, 17, 219–227. doi: 10.1093/ntr/ntu191 [PubMed: 25239961]
- Kong G, Morean ME, Cavallo DA, Camenga DR, & Krishnan-Sarin S (2015). Reasons for electronic cigarette experimentation and discontinuation among adolescents and young adults. *Nicotine & Tobacco Research*, 17, 847–854. doi:10.1093/ntr/ntu257 [PubMed: 25481917]
- Krishnan-Sarin S, Morean ME, Camenga DR, Cavallo DA, & Kong G (2015). E-cigarette use among high school and middle school adolescents in Connecticut. *Nicotine & Tobacco Research*, 17, 810–818. doi:10.1093/ntr/ntu243 [PubMed: 25385873]
- Loukas A, Chow S, Pasch KE, Li X, Hinds Iii JT, Marti CN, ... Perry CL (2016). College students' polytobacco use, cigarette cessation, and dependence. *American Journal of Health Behavior*, 40, 514–522. doi:10.5993/AJHB.40.4.13 [PubMed: 27338998]
- Loukas A, Murphy JL, & Gottlieb NH (2008). Cigarette smoking and cessation among trade or technical school students in Texas. *Journal of American College Health*, 56, 401–407. doi:10.3200/JACH.56.44.401-408 [PubMed: 18316284]
- Ling PM, & Glantz SA (2002). Why and how the tobacco industry sells cigarettes to young adults: Evidence from industry documents. *American Journal of Public Health*, 92, 908–916. doi:10.2105/AJPH.92.6.908 [PubMed: 12036776]
- McMillen RC, Gottlieb MA, Shaefer RMW, Winickoff JP, & Klein JD (2015). Trends in electronic cigarette use among U.S. adults: Use is increasing in both smokers and nonsmokers. *Nicotine & Tobacco Research*, 17, 1195–1202. doi:10.1093/ntr/ntu213
- Mermelstein RJ, Colvin PJ, & Klingemann SD (2009). Dating and changes in adolescent cigarette smoking: Does partner smoking behavior matter? *Nicotine & Tobacco Research*, 11, 1226–1230. doi:10.1093/ntr/ntp127 [PubMed: 19648175]
- Morrison SD, & Talbott LL (2005). TRUCE for advocacy and peer education in tobacco prevention. *Journal of American College Health*, 54, 193–195. doi:10.3200/JACH.54.3.193 [PubMed: 16335320]
- National Institutes of Health. (2015). Population Assessment of Tobacco and Health Retrieved from <https://pathstudyinfo.nih.gov/UI/HomeMobile.aspx>
- National Institute on Drug Abuse. (2004). Monitoring the Future (MTF): A continuing study of the lifestyles and values of youth, 1983, ICPSR08387-v2 Ann Arbor, MI: Inter-university Consortium for Political and Social Research Retrieved from 10.3886/ICPSR08387.v2
- Noland M, Ickes MJ, Rayens MK, Butler K, Wiggins AT, & Hahn EJ (2016). Social influences on use of cigarettes, e-cigarettes, and hookah by college students. *Journal of American College Health*, 64, 319–328. doi:10.1080/07448481.2016.1138478 [PubMed: 26822236]
- Rath JM, Villanti AC, Abrams DB, & Vallone DM (2012). Patterns of tobacco use and dual use in US young adults: The missing link between youth prevention and adult cessation. *Journal of Environmental and Public Health*, 2012, 679134–9. doi:10.1155/2012/679134 [PubMed: 22666279]
- Richter P, Caraballo R, Gupta N, & Pederson LL (2008). Exploring use of nontraditional tobacco products through focus groups with young adult smokers, 2002. *Preventing Chronic Disease*, 5(3), A87. [PubMed: 18558037]
- Saddleson ML, Kozlowski LT, Giovino GA, Hawk LW, Murphy JM, MacLean MG, ... Mahoney MC (2015). Risky behaviors, e-cigarette use and susceptibility of use among college students. *Drug and Alcohol Dependence*, 149, 25–30. doi:10.1016/j.drugalcdep.2015.01.001 [PubMed: 25666362]

- Sanders-Jackson AN, Tan ASL, Bigman CA, & Henriksen L (2015). Knowledge about E-cigarette constituents and regulation: Results from a national survey of U.S. young adults. *Nicotine & Tobacco Research*, 17, 1247–1254. doi:10.1093/ntr/ntu276 [PubMed: 25542915]
- Sidani JE, Shensa A, Barnett TE, Cook RL, & Primack BA (2014). Knowledge, attitudes, and normative beliefs as predictors of hookah smoking initiation: A longitudinal study of university students. *Nicotine & Tobacco Research*, 16, 647–654. doi:10.1093/ntr/ntt201 [PubMed: 24323574]
- Starr G, Rogers T, Schooley M, Porter S, Wiesen E, & Jamison N (2005). Key outcome indicators for evaluating comprehensive tobacco control programs Atlanta, GA: Centers for Disease Control and Prevention Retrieved from http://www.cdc.gov/tobacco/tobacco_control_programs/surveillance_evaluation/key_outcome/pdfs/frontmaterial.pdf
- Sutfin EL, McCoy TP, Morrell HER, Hoepfner BB, & Wolfson M (2013). Electronic cigarette use by college students. *Drug and Alcohol Dependence*, 131, 214–221. doi:10.1016/j.drugalcdep.2013.05.001 [PubMed: 23746429]
- Sutfin EL, Reboassin BA, Debinski B, Wagoner KG, Spangler J, & Wolfson M (2015). The impact of trying electronic cigarettes on cigarette smoking by college students: A prospective analysis. *American Journal of Public Health*, 105(8), e83–e89. doi:10.2105/AJPH.2015.302707
- Trumbo CW, & Harper R (2013). Use and perception of electronic cigarettes among college students. *Journal of American College Health*, 61, 149–155. doi:10.1080/07448481.2013.776052 [PubMed: 25158012]
- U.S. Department of Education, National Center for Education Statistics. (2014). Fast facts Retrieved from <http://nces.ed.gov/fastfacts/display.asp?id=372>
- White HR, Bray BC, Fleming CB, & Catalano RF (2009). Transitions into and out of light and intermittent smoking during emerging adulthood. *Nicotine & Tobacco Research*, 11, 211–219. doi:10.1093/ntr/ntn017 [PubMed: 19246434]
- Yuan M, Cross SJ, Loughlin SE, & Leslie FM (2015). Nicotine and the adolescent brain. *Journal of Physiology*, 593, 3397–3412. doi:10.1113/JP270492 [PubMed: 26018031]

Table 1.

Differences in Sociodemographic Factors Between Students who Initiated ENDS by Wave 3 and Those Who Did Not ($n = 2,110$).

Wave 1 variables	Students who initiated ENDS by Wave 3 ($n = 329$), %	Students who never used ENDS by Wave 3 ($n = 1,781$), %	χ^2 (p)
Gender (male)	38.3	32.7	3.93 (.04)
Age (18–24 years old)	93.3	94.6	0.88 (.36)
Race/ethnicity			
Non-Hispanic White	36.5	35.1	0.21 (.66)
Hispanic/Latino	32.2	25.9	5.67 (.02)
African/American/Black	6.7	7.9	0.54 (.50)
Asian	16.7	24.5	9.50 (.00)
Other	7.9	6.6	0.78 (.40)
Enrollment in a community college	6.7	6.5	0.02 (.90)

Note. ENDS = Electronic Nicotine Delivery Systems. Students who initiated ENDS and those who never used ENDS were grouped based on ever ENDS use. Chi-square analyses were conducted for each sociodemographic characteristic.

Table 2.

Examining the Unadjusted Associations Between the Social Environment, Normative Beliefs, and Attitudes in Predicting ENDS Initiation Among College Students Who Had Never Used ENDS at Baseline ($n = 2,110$).

Wave 1 variables	Odds ratio	SE	95% Confidence interval
Peer ENDS use ^a	1.42***	0.11	[1.23, 1.65]
Social acceptability of ENDS use ^b	1.18***	0.05	[1.08, 1.29]
Inclination to date someone who uses ENDS ^b	1.46***	0.08	[1.31, 1.62]
Household ENDS use ^c	1.60*	0.37	[1.02, 2.50]

Note. ENDS = Electronic Nicotine Delivery Systems. Separate multilevel unadjusted models were examined for each of the Wave 1 independent variables.

^a Scored on a scale from 0 to 4.

^b Scored on a scale from 1 to 5.

^c Scored as 0, 1.

* $p < .05$.

*** $p < .001$.

Table 3.

Multivariable, Multilevel Model Examining the Unique Roles of Social Environment, Normative Beliefs, and Attitudes in Uniquely Predicting Initiation of ENDS, After Adjusting for Sociodemographic Differences and Other Tobacco Use Covariates Among Students Who Never Used ENDS at Baseline ($n = 2,110$).

Wave 1 variables	Odds ratio	SE	95% Confidence interval
Covariates			
Age: Above 24 years (reference)			
18–24 years	3.08***	0.90	[1.74, 5.45]
Gender: Female (reference)			
Male	1.06	0.15	[0.81, 1.39]
Race/ethnicity: Non-Hispanic White (reference)			
Hispanic/Latino	1.14	0.14	[0.90, 1.46]
African American/Black	0.87	0.19	[0.57, 1.32]
Asian	0.91	0.14	[0.68, 1.22]
Other	1.22	0.24	[0.82, 1.80]
Enrollment in a community college (reference)			
Enrollment in a 4-year college	1.14	0.33	[0.65, 2.00]
No. of other tobacco products ever used	2.17***	0.13	[1.94, 2.44]
Social environment, normative beliefs, attitudes			
Peer ENDS use ^a	1.32*	0.12	[1.11, 1.57]
Social acceptability of ENDS use ^b	0.97	0.05	[0.87, 1.08]
Inclination to date someone who uses ENDS ^b	1.23*	0.08	[1.08, 1.39]
Household ENDS use ^c	1.22	0.31	[0.74, 2.02]

Note. ENDS = Electronic Nicotine Delivery Systems.

^a Scored on a scale from 0 to 4.

^b Scored on a scale from 1 to 5.

^c Scored as 0, 1.

* $p < .05$.

100 > d
***

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript