Published in final edited form as:

J Am Coll Health. 2019 ; 67(4): 338–347. doi:10.1080/07448481.2018.1481075.

Measuring characteristics of e-cigarette consumption among college students

Su-Wei Wong, M.A.^a, Hsien-Chang Lin, Ph.D.^a, Megan E. Piper, Ph.D.^b, Adam Siddiqui, MPH^c, and Anne Buu, Ph.D., Ph.D.^{c,*}

^aDepartment of Applied Health Science, School of Public Health, Indiana University, 1025 E. 7th Street, SPH 116, Bloomington, IN 47405, USA

^bCenter for Tobacco Research & Intervention, University of Wisconsin, 1930 Monroe Street, Suite 200, Madison, WI 53711, USA

^cDepartment of Health Behavior and Biological Sciences, University of Michigan, 400 North Ingalls, Ann Arbor, MI 48109, USA

Abstract

Objective: E-cigarette use among college students has increased drastically in recent years. This study aims to inform development of a comprehensive measure of e-cigarette consumption for this population.

Participants & Methods: This mixed-method study collected both quantitative and qualitative data from a sample of 43 experienced e-cigarette users from two college campuses, using a self-reported questionnaire and a semi-structured interview, in March-September of 2017.

Results: College student users found some of the consumption questions in national surveys difficult to answer. Switching nicotine levels, mixing flavors, co-using with alcohol and marijuana, using with others who were vaping or drinking, and vaping in a car or indoor space were all common. The participants defined “regular user” based on ownership of a device rather than on quantity/frequency.

Conclusions: A comprehensive e-cigarette consumption measure should cover the complex characteristics that are potentially associated with negative health consequences such as flavorings, co-use and social contexts.

According to the Surgeon General’s report,¹ the prevalence of ever e-cigarette use among young adults (18–24 years of age) more than doubled from 2013 to 2014 and was the highest in the overall population (35.8% in 2014). College students have historically been at the forefront of societal changes in substance use and a target market for the tobacco industry.² E-cigarettes have novel features that are particularly appealing to college students and are more socially acceptable than combustible cigarettes among college students,³

*Corresponding author at: 400 North Ingalls, Ann Arbor, MI 48109, USA. Tel.: +1 (734) 764-9008; fax: +1(734) 647-2416. E-mail: buu@umich.edu (Anne Buu), suwewong@indiana.edu (Su-Wei Wong), linhsi@indiana.edu (Hsien-Chang Lin), mep@ctri.wisc.edu (Megan Piper), aasiddiq@umich.edu (Adam Siddiqui); buu@umich.edu (Anne Buu).

therefore, they have great potential to penetrate college campuses more widely than combustible cigarettes.

To truly understand e-cigarette use among college students, we need to understand some characteristics of e-cigarette consumption that are directly related to the substance, such as quantity and frequency. We also need to understand psychosocial factors such as social contexts (e.g., vaping with other vapers or at a social gathering) and motivation that play a role in e-cigarette use. Certain combinations of these characteristics (e.g., daily use and motivation to use e-cigarettes to reduce stress) may carry higher risk for addiction that could lead to negative health consequences. Thus, a comprehensive study of the characteristics of e-cigarette consumption among college students could have important implications for prevention and intervention.

Characterizing e-cigarette consumption is challenging because of the many variations and the speed with which these products evolve. Thus, traditional quantity/frequency measures may not fully delineate the consumption of this novel product. In general, the literature shows that higher *frequency* of e-cigarette use is associated with a higher rate of concurrent use of tobacco products, as well as a higher level of nicotine dependence, bronchitis, and depression symptomatology.^{4–7} Quantifying e-cigarette consumption, on the other hand, is not at all straightforward. Multiple *quantity* measures have been proposed such as the number of puffs, episodes, cartridges, and milliliters of e-liquid; yet, information about the reliability and validity of the alternative measures is very limited.⁸ Again, the issue of product variability adds an additional level of complexity. First, some quantity measures only apply to certain types of *devices* (e.g., the volume of e-liquid to the tank system), and thus making quantity measures comparable across devices is challenging. Second, more advanced devices allowing users to control the voltage or coil have been found to be associated with higher nicotine dependence symptomatology.⁹ Third, users can choose different *nicotine levels*, which may reflect users' levels of dependence symptomatology.⁹ Therefore, the quantity/frequency measure alone may not be sufficient to reflect the overall nicotine intake.

A unique characteristic of e-cigarettes is the great flexibility to add a variety of *flavorings* which may be safe for ingestion but could have adverse respiratory toxic effects.^{10–11} A study found that flavorings had significant effects on the smoking and vaping behavior of cigarette smokers asked to adopt e-cigarettes for 6 weeks (e.g., the largest drop in cigarette smoking occurred among those assigned menthol e-cigarettes).¹² Research also showed that tobacco or menthol flavors produced very strong feeling for sensation fulfillment (i.e., throat hit).¹³ Another study involving young adult smokers in behavioral choice tasks in a laboratory setting demonstrated that flavorings enhanced the rewarding and reinforcing value of e-cigarettes with nicotine, and thus their abuse liability.¹⁴

Another consideration in understanding college students' e-cigarette use is that e-cigarettes are likely to be used with other substances. The additive effects of *co-use* of nicotine and alcohol such as increased pleasure, higher ratings of feeling “buzzed” and “dizzy” and higher levels of craving were demonstrated.¹⁵ Further, the high rate of tobacco and marijuana co-use is well documented and both the synergistic and compensatory effects of

co-use are supported by research.¹⁶ Particularly, the e-cigarette device unavoidably offers a convenient and appealing way to administer marijuana among e-cigarette users and thus has great potential to increase the prevalence of marijuana use in this population.

Finally, it is necessary to consider psychosocial factors associated with e-cigarette consumption because they also contain important information about prevention and intervention. The smoking literature shows that among college student smokers, the strongest contextual antecedents for smoking were the presence of others smoking, recently inhabiting an outside location, and being where smoking was permitted.¹⁷ Although *social contexts*, particularly friends' influence,¹⁸ still had profound impact on college students' e-cigarette use, e-cigarettes were commonly used as a substitute for smoking in places where smoking was prohibited.^{19–20} This implies that e-cigarettes have the potential to permit more ubiquitous use of tobacco, and avoid situational barriers imposed on combustible cigarette use.

Studying the *motivation* to use e-cigarettes could provide important insights into health education and policy. Although e-cigarettes were adopted by older, more established smokers mainly for reducing cigarette smoking, e-cigarette use among college students who smoked was not associated with intentions to quit.²¹ Instead, young adults or college students were more likely motivated by the taste, flavor, or positive sensory experiences.
3,8,20

Despite this clear need to understand the complex characteristics of e-cigarette consumption reviewed above, most of the national surveys have only inquired about the *frequency* (e.g., the number of days in past 30 days) of e-cigarette consumption, such as the Monitoring the Future (MTF), the Youth Risk Behavior Survey (YRBS), and the Behavioral Risk Factor Surveillance System (BRFSS). Two national surveys have more questions related to e-cigarette consumption: the National Youth Tobacco Survey (NYTS) and the Population Assessment of Tobacco and Health (PATH) Study. Table 1 lists the relevant questions from both surveys corresponding to the substance related and psychosocial factors reviewed in previous paragraphs. Neither survey has comprehensive coverage of all the characteristics of e-cigarette consumption. The NYTS does not have any items for quantity and nicotine levels, whereas the PATH does not ask about co-use. While the NYTS has more questions about social contexts, the PATH collects more information about features of the device. Further, the items employed in both surveys for quantity or co-use may only produce vague information about these important characteristics. For example, the quantity measured by the PATH is not comparable across participants who use different types of products (e.g., cartridge vs. tank). The above review of five national surveys on items relevant to characteristics of e-cigarette consumption is more comprehensive than a previous review that only covered frequency/quantity, flavors, device type, and nicotine content.²²

Another issue related to measuring e-cigarette consumption is that some terminologies which are straightforward for combustible cigarette use are not well defined for e-cigarette use and vary from survey to survey. While a *regular* smoker is commonly defined as someone who has smoked more than 100 cigarettes in their lifetime and who now smokes every day,²³ it is usually referred to without a definition concerning e-cigarette use. For

example, the PATH asked participants: “have you ever used e-cigarettes fairly regularly?” Further, because there is no natural end point for e-cigarette puffing behavior, the meaning of *episode* (equivalently, “session” or “time”) is unclear. Although this is a necessary measurement unit in some research settings, the definition of one episode varies across studies such as “consists of around 15 puffs or lasts around 10 minutes”⁹ and “taking two or more puffs on an e-cigarette close together and isolated in time from other vaping episodes.”²⁴ Thus, it is necessary to examine how e-cigarette users perceive or communicate about these terminologies in everyday life.

Based on the literature reviewed above it is clear that a comprehensive measure of e-cigarette consumption needs to consider not only frequency and quantity but also device, nicotine levels, flavorings, co-use, social contexts, and use motivation, because all of these characteristics are potentially related to the risk for addiction and subsequent negative health consequences. Existing survey questions, however, have limited coverage on these important characteristics of e-cigarette consumption and provide no or variable definitions about terminologies commonly used in research such as “regular use” and “episode.” This study aims to inform measurement development and promote effective communication between researchers and participants by conducting a mixed-method study on college students who are experienced e-cigarette users using both a self-reported questionnaire and a semi-structured interview.

METHODS

Study Design and Procedure

Given the exploratory nature of some of the content areas covered by this study, we combined a self-reported questionnaire and a semi-structured interview in order to comprehensively examine all the important characteristics of e-cigarette consumption and related terminologies. The questionnaire was designed based on our review of the literature and relevant items in national surveys (see Table 1), including mostly closed-ended questions supplemented by a few open-ended questions. Participants first filled out the questionnaire (5–10 minutes) and then were interviewed by the first author (15–20 minutes) who is a trained qualitative sociologist with extensive experience in conducting interviews. The interview was semi-structured with pre-determined open-ended questions covering the following topics: 1) How do e-cigarette users quantify e-cigarette consumption? 2) What is the definition of being a “regular user” of e-cigarettes? 3) How do e-cigarette users define an “episode” of e-cigarette use? 4) Why is the flavoring of e-liquid important to users? 5) What are the common types of marijuana used via e-cigarettes devices? and 6) What are the common social contexts of e-cigarette use?

Participant Eligibility and Recruitment

We recruited participants from a Midwest college campus in the spring semester and another Midwest college campus in the fall semester of 2017. The Internal Review Board (IRB) at both universities granted us an exempt status because the participants remained anonymous. Participants were recruited by either: 1) an email invitation to various student groups in the university; or 2) approaching potential e-cigarette users outside a bar, pub, restaurant, or e-

cigarette shop/lounge. The latter method turned out to be more productive. A \$20 gift card was offered as a token of appreciation after each participant completed the questionnaire and interview. We recruited a total of 43 eligible participants from the two campuses (14 and 29, respectively).

The inclusion criteria were: 1) being a college student aged 18–25; 2) having at least 6 months of experience with e-cigarette use; 3) using a 2nd or 3rd generation e-cigarette (i.e., an open-system that requires the user to replace the cartridge or refill the e-liquid tank); and 4) using an e-cigarette containing nicotine instead of just flavor.

Data Analysis

Quantitative data collected by the questionnaire were summarized with descriptive statistics using SAS 9.4. The inductive thematic approach, a qualitative method that identifies key themes, concepts, and categories best describing a phenomenon scientifically without attempting to fit the data into a pre-existing model or frame,²⁵ was adopted to analyze the qualitative data collected from the interview. The qualitative data were transcribed verbatim based on audio recording, and then reviewed and categorized to reflect the recurring themes under the six topics listed in the Study Design and Procedure Section. The authors also discussed extensively to reach consensus of the themes that are most appropriate for each of the six topics. Microsoft Excel was used for coding qualitative data.

RESULTS

Descriptive Statistics Based on Responses to the Questionnaire

Table 2 shows descriptive statistics of demographic information and smoking and vaping history of the sample of 43 college students with the mean age of 20. Seventy-seven percent of them were male and 95% were white. Forty-four percent of them had smoked more than 100 cigarettes in their lifetime and 30% were self-identified current smokers. Further, the average onset age of e-cigarette use was 18 and the mean duration of e-cigarette use was about 2.5 years.

Frequency and quantity—Table 3 summarizes the characteristics of e-cigarette consumption in the study sample. While most participants (91%) could easily answer the number of days using e-cigarettes, only 58% could recall the number of use events per day. Additionally, the latter question had a large variance indicating that it may not be a reliable item. The questions on quantity both had large variances and were difficult for about 30% of the participants to answer. In addition, 35% used less than 1 cartridges/tank refills a day (coded as 0) suggesting that this measurement unit may be more applicable to a longer timeframe (e.g., a week).

Device and nicotine levels—With respect to devices, about 91% of the participants were able to name the brands of their devices which we categorized into three models in the order of the users' skill levels that may be associated with dependence symptomatology. In terms of nicotine levels, the majority of participants (56%) used 3 mg/ml, although two students used very high levels (25 or 50 mg/ml), resulting in a large variance. The data also show that

adjusting the nicotine levels was very common among college student users (74%) with the majority adjusting it to a lower level (44%).

Flavorings and co-use—We categorized the open-ended responses to three major categories based on the ratio of vegetable glycerine (VG) to propylene glycol (PG) because the flavorings containing more PG (e.g., tobacco, menthol, or beverage) were associated with more sensation fulfillment such as “throat hit.”¹³ We also added an additional category for those “cocktail” flavors that were custom made in some vape shops (about 30%). The flavor was very important to college users (with the mean score of 4.37 on a 5-point scale). The majority of participants had mixed flavors to create personal flavors (63%). Concerning co-use, 60% of the participants also used other substances while vaping with 30% co-using with alcohol and 35% with marijuana (not as an additive to the e-cigarette device).

Social contexts and motivation—In terms of social contexts of vaping, the most common occasions were being with other vapers (74%), social gathering (49%), being in a car (49%) and being in indoor space (47%). The three most common motivations for e-cigarette use (of the 8 options) were: replacing traditional cigarette or tobacco product (63%), it is/might be less harmful (60%), and more flavor choices (51%).

Qualitative Findings Based on the Interview

How do e-cigarette users quantify e-cigarette consumption?—We asked the participants how would they describe the quantity of their e-cigarette use. Most of the respondents preferred to measure it by the number of cartridges or the number of tank refills (51%). One-third of the participants (33%) preferred to report the number of bottles of e-liquid (one bottle amounts to multiple tank refills) and 26% preferred to measure it by the number of puffs. Only 12% of the students suggested to use the number of milliliters of e-liquid. In terms of the timeframe for each measure, “a day” was more appropriate for puffs or milliliters whereas “a week” fit better with cartridges, tank refills, or bottles.

What is the definition of being a “regular user” of e-cigarettes?—The majority of the college students (49%) who were interviewed considered themselves regular users of e-cigarettes or no longer experimenters when they got their own devices. Buying their own devices appeared to indicate that they were no longer satisfied with the features of other people’s devices. For example, a student who used to use someone else’s device said, “I got a better one and it makes bigger cloud...and I stuck to it and I was into it...” The ownership also allowed them to vape wherever and whenever they wanted. A student said, “...when I actually bought a tank and mod so I can use it in my car and my home.” Additionally, the ownership is a sign of commitment, for example, a student said, “I got used to it (by using friend’s) and I got my first one... that’s when I committed to it...” Interestingly, about 23% of the participants considered themselves regular users when using e-cigarettes became a hobby. An example of the responses is: “When I realize it has become somewhat like a hobby, when I mix the juices and build coils... or shopping different mods...” Moreover, when asked about how long did it take for him/her to become a regular user, 35% reported “less than 1 month” and 26% “3–6 months.”

How do e-cigarette users define an “episode” of e-cigarette use?—This topic was added into the interview on the second site (N=29). We first asked the participants whether they felt the conventional definition of one episode of e-cigarette use, “15 puffs or 10 minutes,”⁹ was appropriate. To our surprise, 28 out of the 29 students did not think so. We further asked them to suggest better ones. Seven students suggested to only use the number of minutes (median = 10). Another eleven students suggested to only use the number of puffs (median = 5). Still other nine students suggested to use both criteria with the medians being 10 minutes and 5–10 puffs.

Why is the flavoring of e-liquid important to users?—About 88% of the participants thought taste was a contributing factor in their e-cigarette use. Most of them compared the taste of e-cigarettes with that of combustible cigarettes. A student said, “When I was smoking my breath is terrible, but with these flavors, they taste a lot nicer to me and people around me...” Another student mentioned the lasting effect of the flavoring, “So... the taste of the juice would stay in your mouth...so if you gonna be stuck with a taste, it’s better if the taste is nice.” Furthermore, seven students reported that they had tried different flavors and found some particularly “enjoyable.”

What are the common types of marijuana used via e-cigarettes devices?—We added this topic to the interview conducted on the second site where medical marijuana was legal (N=29). Based on limited literature on marijuana use by vaporization/e-cigarettes,^{26–27} we originally showed the participants the following categories: 1) dried leaves/herbs; 2) THC/CBD-laced e-liquid; and 3) THC/CBD wax. Fortunately, the first participant who worked in a shop selling both marijuana and e-cigarette products suggested to add THC/CBD oil because it is quite accessible to college students. Therefore, we consistently asked the rest of the participants whether these four categories made sense. About 79% of the participants agreed while 21% did not know. Additionally, no other categories were suggested. A total of 62% of the participants had ever vaped marijuana using e-cigarettes: 48% had used THC/CBD wax; 45% had used THC/CBD-laced e-liquid; 34% had used THC/CBD oil; and 24% had used dried leaves/herbs.

What are the common social contexts of e-cigarette use?—We first asked the participants whether there were certain social contexts (including occasions, people, and locations) that made him/her want to use e-cigarettes more than usual and 77% of them responded positively. We further asked them to specify these contexts. The most common social context was being with other vapers (74%) such as “When I am hanging out with some friends...people who don’t mind me vaping or even doing it with me.” The second common context was social gatherings that involved alcohol (49%) such as fraternity parties, football games, and festivals. Another popular context was being in a car (49%). For some students, using e-cigarettes made driving easier such as “it keeps me awake and less anxious.” For other students, their cars were their own spaces so they had the freedom to be “doing my things” or “not bothering anybody.” The fourth place was being in an indoor space (47%) such as “my room,” “on my bed,” or “a friend’s house.”

COMMENT

This mixed-method study makes two unique, significant contributions to the literature of e-cigarette research. First, we have conducted a comprehensive review of existing literature and national survey questions on the characteristics of e-cigarette consumption that are potentially related to addiction or negative health consequences. Secondly, building upon this review, we conducted a new study focusing on how to measure key characteristics related to e-cigarette consumption in college students, a population that is particularly vulnerable to the impact of e-cigarette use. Our approach took advantage of both quantitative and qualitative data that not only broaden but also deepen the current knowledge of relevant measurement issues.^{8,28} The following recommendations for measurement development as well as public health policy and clinical implications are based on the results of both types of data.

Recommendations for Measurement Development

Although regular smokers have been conventionally defined using quantity (100 cigarettes) and frequency (every day), it is challenging to define regular users of e-cigarettes given the complexity of quantifying e-cigarette consumption. We took a different approach by attempting to look at this issue from users' perspectives. According to the qualitative findings, college students considered themselves regular e-cigarette users based on their *ownership* of the devices instead of the quantity or frequency of their e-cigarette consumption, because the former indicates a transition from experimental use to personalized use, a habit, or a sign of commitment.

In terms of the *frequency* of e-cigarette consumption, although most of the participants can answer the question about the number of days in the past 30 days, many had difficulty answering how many "times" a day. If the latter item is necessary, we suggest that researchers may add a definition of an episode as *5 puffs or 10 minutes* (i.e., the medians of our data).

Concerning the need to develop a *quantity* measure comparable across different types of users, we suggest that researchers first ask whether the participant uses the cartridge or the tank system and then lead them to different sets of follow-up questions accordingly: cartridge users are asked about the brand and number of cartridges used whereas tank users are asked about the volume and number of e-liquid bottles used. Users of both systems would answer within the timeframe of a week. In this way, the total quantity can be later calculated and comparable across users. We hesitate to recommend measuring the number of tank refills because the volumes of tanks are too variable and thus make it difficult for calculating the total quantity that would be comparable across users.

Regarding the features of *devices*, we suggest that researchers ask about whether users can adjust voltage or build their own coils because a higher skill level may reflect a higher level of dependence. Further, the items of *nicotine levels* and *flavorings* in the PATH Study has a comprehensive coverage of currently available options in the market so researchers may adopt them in future projects. In terms of *co-use*, we suggest that researchers ask about what percent of time e-cigarette was co-used with alcohol and what percent of time e-cigarette

was co-used with marijuana. We also suggest that researchers with a special interest in marijuana ask about the type of marijuana used via an e-cigarette device.

Psychosocial constructs should also be included in a comprehensive e-cigarette consumption measure. Concerning *social contexts*, we suggest that researchers inquire about whether participants mostly use alone or with others; indoor or outdoor; if with others, whether others were also using alcohol or other substances. Finally, the PATH Study has a comprehensive coverage of possible *motivation* for e-cigarette use. Based on the responses of our college sample, we recommend the following choices for young adults: replacing traditional cigarette or tobacco product, being less harmful, offering more flavor choices, party trick, and trying to quit smoking.

In comparison to other qualitative studies that provided recommendations for measurement development,^{8,28} our recommended quantity standard (5 puffs) for an episode tends to be lower. This may be due to the younger age of our sample. Additionally, our study has unique coverage of the issue of co-use because of the high prevalence of co-use among college students. This issue has not been considered in previous studies focusing on the adult or general population.^{8,22,28,29} Although there is a consensus on the difficulty in quantifying e-cigarette consumption,^{8,22,28} our study took a further step to propose a quantity measure that is comparable across different types of users. Another unique contribution of our study is that we proposed to define regular users of e-cigarettes based on the ownership of devices. This represents a paradigm shift from the conventional way of defining regular users based on frequency or duration which tend to vary across previous studies.^{22,29} Moreover, there are some recent publications that recommended minimum core items to assess e-cigarette use in national surveys,²⁹ or summarized survey items on e-cigarette perceptions (benefits, harm, addiction, and social norms).³⁰ These recommendations may be considered if researchers are interested in developing a short measure for the general population or a comprehensive measure for perceptions.

Public Health Policy Implications

Although several states in the U.S. have implemented a partial or comprehensive indoor smoking ban and colleges have banned tobacco product use on campus, these bans do not necessarily include e-cigarette use. Additionally, some college campuses do not ban any use of tobacco products in a car. Our findings that around half of the participants used e-cigarettes in indoor settings and about half of them used e-cigarettes in a car, suggest further consideration of inclusion of emerging tobacco products as well as indoor settings such as cars in these bans, especially on college campuses. Furthermore, another result of our study shows that the majority of participants used e-cigarettes with flavorings that could help them fulfil sensation, and may in turn, reinforce the attractiveness of e-cigarettes to college students. This alarming finding suggests that regulations on adding and labeling flavorings of e-cigarettes will be needed if the scientific evidence of adverse health consequences due to artificial flavorings emerges in the future.

Clinical Implications

This research provides some interesting insights into how and why college students are using e-cigarettes. More than half of participants reported using e-cigarettes to replace combustible cigarettes. The interest in switching from combustibles to e-cigarettes, and the fact that almost half of participants reported using them because they were safer than combustible cigarettes, suggest that this population is motivated to quit smoking. An emphasis needs to be made to focus on complete substitution, and not using e-cigarettes only when they can't smoke combustibles. It is also important to note that only 16% reported having tried to quit using e-cigarettes, despite the mean duration of use for 2.5 years. This lack of interest in quitting e-cigarette use may have important clinical implications if future research reveals that e-cigarettes do, indeed, produce adverse health effects.

Limitations

Given the relatively small sample size and both study sites in the Midwest, the results may not be generalizable to the entire American college population. Future studies involving representative samples of college students should be used to validate the comprehensive consumption measure recommended by this study. Another limitation of this study is that we did not ask participants to bring their devices, so we were not able to validate their self-reported answers. Nevertheless, the in-depth qualitative data have provided unique insights into important characteristics of e-cigarette consumption that may not be attainable by a large sample survey.

Conclusions

This study provides recommendations for developing a comprehensive e-cigarette consumption measure covering the complex characteristics that are potentially associated with addiction and negative health consequences in the college population, including frequency, quantity, device features, nicotine levels, flavorings, co-use, social contexts and motivation. We also suggest definitions for commonly used terminologies in tobacco research including “episode” and “regular user” from college student users' perspectives, which may promote effective communication between researchers or practitioners and participants or students in future research or intervention programs.

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Table 1

National survey items related to characteristics of e-cigarette consumption.

Characteristics	National Youth Tobacco Survey (NYTS)	Population Assessment of Tobacco and Health (PATH) Study
Substance related factors		
Frequency	•During the past 30 days, on how many days did you use e-cig?	•On how many of the past 30 days, did you use an e-cig?
Quantity	N/A	•On average, on those days you used, how many e-cig/cartridges/milliliters of e-liquid did you usually use each day?
Device	•What brands of e-cig have you ever tried? •Thinking about all types of e-cig, have you used the disposable kind or rechargeable/refillable tank kind?	•What brand of e-cig do you usually use? •Is your e-cig rechargeable? •Does your e-cig use cartridges? •Does your e-cig use a tank system? •Can you refill your e-cig with “e-liquid”? •Can you change the voltage on your e-cig? •Have you modified your e-cig at all?
Nicotine levels	N/A	•What concentration of nicotine do you usually use?
Flavorings	•Which of the following tobacco products that you used in the past 30 days were flavored to taste like...?	•Which flavors have you used in the past 30 days? If multiple flavors were mixed together, choose all that apply.
Co-use	•Have you ever used an e-cig device for any other substance other than for nicotine?	N/A
Psychosocial factors		
Social contexts	•During the past 30 days, on how many days did you breathe the vapor from someone who was using an e-cig in an indoor or outdoor public place? •Does anyone who lives with you now use? (A list of tobacco products) •Out of every 10 students in your grade at school, how many do you think use e-cigarettes?	•Does anyone else living in your home own an e-cig?
Motivation	•What are the reasons why you have used e-cigarettes? (Choose all that apply from 7 options)	•I use e-cigarettes because: (Choose all that apply from 13 options)

Table 2

Descriptive statistics of demographic information and smoking and vaping history of the college sample (N=43).

Variable	N (%) or Mean (SD)
Demographic information:	
Age	20.23 (2.03)
Gender (Male)	33 (77%)
Race	
White	41 (95%)
Black	1 (2%)
Asian	1 (2%)
Smoking and vaping history:	
Have smoked more than 100 cigarettes in lifetime	19 (44%)
Current smoker	13 (30%)
Number of cigarettes used per day among current smokers	4.75 (3.01)
Onset age of e-cigarette use	17.98 (1.88)
Duration of e-cigarette use (months)	29.74 (16.71)
Have ever tried to quit using e-cigarettes	7 (16%)
Consider oneself addicted to e-cigarettes	8 (19%)
How long did it take to become addicted to e-cigarettes among self-identified e-cigarette addicts (months)	5.46 (5.91)
Owning an e-cigarette device	39 (91%)

Table 3

Descriptive statistics of e-cigarette consumption characteristics of the college sample (N=43).

Characteristics	N(%) or M(SD)
Frequency	
How many days in the past 30 days have you used e-cig? (9% can't answer)	23.41 (9.32)
How many times a day do you use e-cigarette? (42% can't answer)	20.80 (45.24)
Quantity	
How many puffs do you take from an e-cigarette a day? (33% can't answer)	190.28 (409.59)
How many cartridges/tank refills do you use a day? (30% can't answer; 35% used less than 1 per day)	1.57 (3.02)
Device *	
Basic models (cartridges; no voltage adjustment)	10 (23%)
Advanced models (tanks; users have the flexibility to adjust voltage)	27 (63%)
Mechanical models (tanks; require users to build their own coils)	2 (5%)
Nicotine levels	
Specify the concentration level of nicotine you usually use in the cartridge/tank (mg/ml)? (14% can't answer)	5.65 (8.44)
Have you adjusted the level of nicotine?	
No	11 (26%)
Yes, to higher	9 (21%)
Yes, to lower	19 (44%)
Yes, higher and lower	4 (9%)
Flavorings *	
Fruits, cream, or nuts: more vegetable glycerine (VG)	7 (16%)
Tobacco, menthol, or beverage: more propylene glycol (PG)	5 (12%)
Sweet or seasonings: balanced VG/PG	2 (5%)
Cocktail of multiple flavors	13 (30%)
How important is the flavor of e-liquid to you? 1 (not important at all) to 5 (very important)	4.37 (0.76)
Have you ever mixed two or more flavored e-liquids together to create your personal flavor? (Yes)	27 (63%)
Co-use	
Do you use any substances while using e-cigarette?	
No	17 (40%)
Yes, sometimes	20 (46%)
Yes, always	6 (14%)
If yes, what were you using?	
Co-use with alcohol	13 (30%)
Co-use with marijuana	15 (35%)
Social contexts	
What kind of occasion makes you vape more than usual? *	

Characteristics	N(%) or M(SD)
Being with other vapers	32 (74%)
Social gathering	21 (49%)
Being in a car	21 (49%)
Being indoor space (e.g., friend's house, home, dorm room)	20 (47%)
Motivation	
Why do you use e-cigarettes?	
Replacing traditional cigarette or tobacco product	27 (63%)
It is/might be less harmful	26 (60%)
More flavor choices	22 (51%)
Party trick	14 (33%)
Trying to quit traditional cigarette or tobacco product	13 (30%)
Cost reason	10 (23%)
It looks cool	5 (12%)
Peer pressure/socializing tool	3 (7%)

* Based on open-ended questions in the questionnaire or the semi-structured interview.