Young Adults' Electronic Cigarette Use and Perceptions of Risk

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ABSTRACT

In the United States, 18.6% of college students between 19-and 22-years old report e-cigarette use in the last 30 days. Information regarding e-cigarette use and perceptions in this age group may assist in understanding how to decrease initiation of e-cigarettes in a population that may otherwise not use nicotine. The purpose of this survey was to determine current e-cigarette use and how e-cigarette use history relates to a college student's perceptions of health risks associated with e-cigarettes. A 33-item questionnaire was sent to students at a Midwestern university in Fall 2018. Overall, 3754 students completed the questionnaire. More than half of the respondents (55.2%) had used e-cigarettes and 23.2% identified as current users of e-cigarettes. Current e-cigarette users were more likely to agree that e-cigarettes are a safe and effective option to quit smoking, while never users were more likely to disagree (safe $P < .001$, effective $P < .001$). Current users were less likely to agree that e-cigarettes may harm a person's overall health than never users ($P < .001$). Young adults continue to be frequent users of e-cigarettes. There are significant differences in perceptions of e-cigarettes associated with use history. Additional research is needed to see how perceptions and use of e-cigarettes have changed considering lung injury reports and increased regulations in the U.S.

KEYWORDS: Electronic cigarette, vape, college student, perception, Electronic Nicotine Delivery Systems

Introduction

In the United States, 25.8% of young adults between 18 and 24 identify as ever using an e-cigarette, making them the largest consumers of e-cigarettes in the country.[1] Among college students between 19 and 22 years old, use of e-cigarettes rose dramatically from 2017 to 2020, increasing from 6% to 18.6%.[2] In youth and young adults, the increase in e-cigarette use is multifactorial; however, having a friend or family member who uses, availability of flavors, and a perception that e-cigarettes are less harmful than other forms of tobacco have been cited as the most common reasons for e-cigarette initiation.[3]

Research has shown that e-cigarette users obtain plasma nicotine concentrations similar to combustible products.[4,5] Many adolescents try flavored e-cigarette products because of social pressures without knowing they contain nicotine, which can lead to nicotine addiction, transition to traditional cigarettes and use of marijuana.[1-12] In addition to nicotine, most e-liquid contains ultrafine particles, flavorants, volatile organic compounds, and heavy metals, which have been linked to health issues such as lung disease, heart damage, and decreased wound healing.[1-14] Although e-cigarettes are now regulated by the Food and Drug Administration and serious health consequences, such as e-cigarette or vaping-associated lung injury (EVALI) have been realized, use among youth and young adults remains high. Regardless of the source of exposure, youth, and young adults consuming nicotine before the maturation of the prefrontal cortex are at an increased risk of drug-seeking behavior, attention and cognition deficits, and mood disorders, risks that are unique to this age group.[11] Despite the known risks associated with e-cigarettes, focusing on their harms seems to be most beneficial in keeping non-users from turning to e-cigarettes but does not seem to impact current e-cigarette users.[7]

Considering the frequent use of e-cigarettes among college-age students, perceptions within this group about e-cigarettes may provide insight into patterns of use and gaps in knowledge regarding safety and risks. The primary objective of this study was to evaluate how tobacco use history affects college students' perceptions of e-cigarettes and knowledge of e-cigarette risks.

Materials and Methods

Instrument

A cross-sectional questionnaire regarding e-cigarettes and tobacco products was created based on a review of the Centers for Disease Control (CDC) National Youth Tobacco Survey (NYTS), current e-cigarette publications, tobacco publications, and related news releases.[15-19] The NYTS was used as a guide to quantify tobacco and e-cigarette use, while the publications by

Weaver et al and Gibson et al provided a framework for the questions about perception of benefits and harms related to e-cigarettes. Survey questions about e-cigarettes and smoking cessation were modeled after those found in the publication by Franks et al.[19] Additional insight was gathered by visiting local vape shops to help guide terminology and trends in e-cigarette use. A draft questionnaire was presented at a roundtable discussion to 20 faculty and administrators for feedback. To further improve validity, the authors invited four college students to pilot the survey and review it for readability. To assess reliability, 17 college students piloted the online questionnaire two times each about one week apart. Responses of those students were evaluated using Spearman's correlation coefficients and Cronbach's alpha. A statistician reviewed the validity results and final revisions were made to the questionnaire. The study was deemed exempt by the authors' Institutional Review Board (IRB).

The questionnaire was built with conditional logic to learn about personal use of various tobacco forms based on definitions from the NYTS.[18] Participants were divided into three groups current user, past user or never. Consistent with the NYTS, use of traditional cigarettes was defined as smoking at least 100 cigarettes or 5 packs ever. Use of combustible non-cigarette tobacco (cigars, cigarillos, pipes, hookah, or little filtered cigars) was defined as smoking at least 50 times ever. Use of smokeless tobacco (chewing tobacco, snuff, snus, or dip) was defined as at least 20 uses ever. Use of e-cigarettes was defined as using at least once ever. Never users are all participants who selected "no" when asked if they had ever used the amount of tobacco product as defined. To determine if participants were current or past users, participants were asked if they now use each product every day, some days or not at all. Those who selected every day or some days were considered current users. If participants selected not at all then they were considered past users. Perception of e-cigarettes compared to other tobacco products was assessed using a 6-point Likert scale with 1 = strongly disagree, 2 = disagree, 3 = somewhat disagree, 3.5 = unsure, 4 = somewhat agree, 5 = agree, 6 = strongly agree. Additional questions asked about perceived risks and benefits of e-cigarettes.

Sampling Strategy

In September 2018, the finalized 33-item questionnaire was sent from an online platform (www.questionpro.com, QuestionPro, Austin, TX) to 13 250 enrolled students' university email accounts. The email contained a link to the questionnaire and introduced the questionnaire by stating the purpose was to collect perceptions of electronic cigarettes and tobacco products Age less than 18 years or no knowledge of what an e-cigarette or vaping is, were used as exclusion criteria. At the end of the survey there was an option to enter a drawing for one of eight $25 gift cards. This allowed all research survey responses to remain anonymous. The survey was open for four weeks, during

which time students received reminder emails at one and two weeks.

Statistical Analysis

Frequencies and descriptive statistics were conducted on demographics, tobacco use, and perceptions. Questionnaire responses were compared between different e-cigarette use history by never use, past use, and current use. Chi-squared tests were used for categorical variables (eg, gender, race). For ordinal variables such as Likert scale questions and age, and Kruskal-Wallis tests were used for comparisons of three groups. A *P*-value of < .05 was considered statistically significant. All statistical analysis was performed using STATA/SE version 13 (Stata Corp, College Station, TX).

Results

A total of 3754 (28.3%) university students participated in the survey. Most participants identified as White (85.5%) and female (59%). The median age of respondents was 21 years old [IQR 19-23]. As for tobacco use history, 3128 (83.3%) students had never used traditional cigarettes, while 230 (6.1%) were current users and 396 (10.5%) were past users. Other forms of combustible non-cigarette tobacco were similar with 2959 (78.8%) never, 361 (9.6%) current and 433 (11.5%) past use. For smokeless tobacco 3422 (91.1%) reported never, 135 (3.6%) current, and 195 (5.2%) past use. More than half of the respondents 2072 (55.2%) had used e-cigarettes at least once in their lifetime and 870 (23.2%) identified as current users of e-cigarettes. Current users were defined as using e-cigarettes every day 420 (11.2%) or somedays 450 (12%). Dual use of e-cigarettes and other tobacco products was reported in 413 (11%) of respondents.

Table 1 describes the demographics of the survey population reported by current, past, or never e-cigarette use. Most current and past e-cigarette users have never used any other tobacco product.

Perceptions regarding e-cigarettes reported by current, past, and never users were significantly different on all items, except all groups agreed that e-cigarettes are addictive (Table 2). Current e-cigarette users were more likely to agree that e-cigarettes are a safe and effective option to quit smoking, while never users were more likely to disagree (safe 4.2 vs 2.7, *P* < .001, effective 4.5 vs 2.9, *P* < .001). Also, never users were more likely to be unsure if e-cigarettes are safer than other tobacco products while current users were more likely to agree e-cigarettes are safer (traditional cigarettes 4.9 vs 3.5, non-cigarette smoke tobacco 4.6 vs 3.3, smokeless tobacco 4.8 vs 3.4, *P* < .001).

Differences among user groups were also observed regarding the perceived potential health effects of e-cigarettes. Current users were significantly less likely to associate personal injury, mouth/throat irritation, and lung damage with e-cigarettes than

Table 1. Descriptive summary of respondent characteristics based on e-cigarette use.

		E-CIGARETTE USE, N (%)		
		CURRENT	PAST	NEVER
Gender[a]	Male	480 (55.2%)	490 (40.8%)	542 (32.2%)
	Female	381 (43.8%)	704 (58.6%)	1131 (67.2%)
	Other	9 (1.0%)	8 (.7%)	9 (.5%)
Age[a]	Median [IQR]	19 [18-21]	21 [20-23]	21 [19-25]
	Black	24 (2.8%)	38 (3.2%)	95 (5.7%)
Race[a]	Other	80 (9.2%)	127 (10.6%)	180 (10.7%)
	White	766 (88.1%)	1037 (86.3%)	1407 (83.7%)
Traditional cigarette use[a]	Current	131 (15.1%)	85 (7.1%)	14 (.8%)
	Past	143 (16.4%)	159 (13.2%)	97 (5.8%)
	Never	596 (68.5%)	960 (75.3%)	1571 (93.4%)
Combustible non-cigarette tobacco use[a]	Current	210 (24.14%)	118 (9.8%)	33 (1.96%)
	Past	159 (18.28%)	199 (16.6%)	75 (4.46%)
	Never	501 (57.59%)	883 (73.5%)	1574 (93.58%)
Smokeless tobacco use[a]	Current	68 (7.8%)	135 (11.24%)	10 (.6%)
	Past	95 (10.9%)	195 (16.24%)	25 (1.5%)
	Never	707 (81.3%)	1068 (88.93%)	1646 (97.9%)

[a]$P < .001$, Kruskal-Wallis test for age, Chi-squared test for other variables.

past and never users (Table 3). Past and never users tended to associate more health risk globally with e-cigarettes than current users. Significant differences between the groups continued in possible perceived benefits of e-cigarettes (Table 4). Current and past e-cigarette users, respectively, believe e-cigarettes are more convenient than combustible tobacco (75.5% vs 61.8%), taste good (72.9% vs 55.9%) and have less odor than traditional cigarettes (69.5% vs 53.2%). Never e-cigarette users compared to current and past users were significantly more likely to believe there are no benefits to e-cigarettes (25.5%, 1.4%, 9.8% respectively, $P < .05$).

Discussion

In this cross-sectional study, over half of participants reported having ever used e-cigarettes and nearly a quarter identified as current users. This correlates with recent publications showing among college students, 47.3%% report lifetime use of vaping nicotine and 18.6% reporting use in the last 30 days.[2] Combined with our data, this shows that the current U.S. vaping epidemic is not only in teens but continues into young adulthood. This is especially concerning as college-aged students are vulnerable to marketing and experimenting with substances to cope with stress.[20]

Several notable trends were identified among current e-cigarette users. Most e-cigarette users (current and past) reported no previous use of tobacco, representing a new generation of nicotine dependence that may possess unique implications. Perceptions of current e-cigarette users indicate they acknowledge e-cigarettes may be harmful to a person's overall health and safer than other forms of tobacco. Current users also recognized e-cigarettes may be addictive like non-users, aligning with the risk-taking behavior that may be more common in this population. Many current e-cigarette users reported also using traditional cigarettes, non-cigarette combustible tobacco, or smokeless tobacco. This represents an alarming trend of dual use among e-cigarette users and signifies e-cigarettes are not being used solely to replace other forms of tobacco.

This study is unique in that we identified perceptions of specific harms related to e-cigarette use. This may be an area of focus to prevent e-cigarette initiation in a population who otherwise would not use nicotine, although warnings about harm from e-cigarettes may not reach those individuals most vulnerable to product initiation. Previous studies have found varying understanding of addiction related to e-cigarettes.[21,22] In one study when young adults were asked if Juuling was dangerous and why, the majority responded yes, but the study had even distribution as to the reason between nicotine, addiction and if it affects your health.[21] In another study, respondents had difficulty reporting the nicotine content of their pod devices and were unsure how it compared to traditional tobacco nicotine content.[22] This research finding less than half

Table 2. Perceptions of e-cigarettes based on e-cigarette use.

	E-CIGARETTE USE, MEAN (SD)			
	CURRENT (N = 870)	PAST (N = 1202)	NEVER (N = 1682)	P VALUE*
E-cigarettes are a safe option to quit smoking.	4.2 (1.2)	3.3(1.3)	2.7(1.3)	<.001
E-cigarettes are an effective option to quit smoking.	4.5(1.2)	3.6(1.4)	2.9(1.3)	<.001
E-cigarettes may harm a person's overall health.	4.3(1.1)	4.7(1.1)	4.8(1.2)	<.001
E-cigarettes are safer than traditional cigarettes.	4.9(1.1)	3.9(1.4)	3.5(1.4)	<.001
E-cigarettes are safer than non-cigarette smoke tobacco (cigars, pipes, cigarillos, hookah).	4.6(1.2)	3.7(1.3)	3.3(1.3)	<.001
E-cigarettes are safer than smokeless tobacco products (chew, snuff, dip, snus).	4.8(1.2)	3.9(1.4)	3.4(1.4)	<.001
E-cigarettes are addictive.	4.7(1.3)	4.9(1.2)	4.9(1.1)	.058
E-cigarettes are more socially acceptable than traditional cigarettes.	4.9(1.1)	4.6(1.3)	4.1(1.4)	<.001

Scoring: strongly disagree-1, disagree-2, somewhat disagree-3, unsure-3.5, somewhat agree-4, agree-5, strongly agree-6.
*Kruskal-Wallis test.

Table 3. Perceived potential health effects of e-cigarettes reported by e-cigarette user groups.

HEALTH EFFECTS	E-CIGARETTE USE*		
	CURRENT (N = 870)	PAST (N = 1202)	NEVER (N = 1682)
Anxiety[a]	17.0%	26.2%	30.3%
Asthma[a]	34.4%	54.8%	59.0%
Cancer[a]	36.0%	59.0%	61.2%
Cough[a]	61.7%	73.5%	72.0%
Explosion/Burn[a]	37.8%	52.5%	54.0%
Mouth irritation[a]	53.0%	67.7%	69.4%
Lung infection[a]	34.9%	58.2%	63.9%
Lung damage[a]	40.7%	63.1%	65.8%
None[a]	5.3%	1.8%	.5%
Unsure	10.5%	10.7%	12.7%

*Percentages were calculated by using responses of respective users of e-cigarettes, respondents were not limited to a single response regarding perceived health effects of e-cigarettes.
[a]$P < .05$, *Kruskal-Wallis test.*

Table 4. Perceived potential benefits of e-cigarettes reported by e-cigarette user groups.

BENEFITS	E-CIGARETTE USE*		
	CURRENT (N = 870)	PAST (N = 1202)	NEVER (N = 1682)
More convenient than tobacco[a,b]	75.5%	61.8%	42.5%
Cheaper alternative to tobacco[a]	50.0%	29.8%	19.6%
Easier to inhale than tobacco[a]	38.6%	26.0%	13.8%
Fit in/look cool[a]	20.8%	24.3%	16.9%
Flavor/tastes good[a]	72.9%	55.9%	31.2%
Healthier option than tobacco[a]	57.9%	31.2%	19.4%
Less odor than tobacco[a]	69.5%	53.2%	35.9%
To quit cigarettes[a]	63.7%	50.4%	36.9%
To quit other forms of tobacco[a]	53.8%	41.3%	29.1%
More socially acceptable than tobacco[a]	46.6%	40.3%	26.4%
Stress relief[a]	58.1%	36.7%	21.4%
None[a]	1.4%	9.8%	25.5%

*Percentages were calculated by using responses of respective users of e-cigarettes, respondents were not limited to a single response regarding perceived benefits of e-cigarettes.
[a]$P < .05$, *Kruskal-Wallis test*,
[b]indoor use, no trash, no ashtray etc.

of people notice warning labels on e-cigarettes suggests additional education needs to be provided regarding nicotine, addiction and known health effects of all tobacco products.[20] The impact of Tobacco 21 laws, which prohibit the sale of tobacco and vaping products to anyone less than 21 years of age, and flavor bans on reducing e-cigarette use and initiation in youth and young adults is yet to be realized in the United States.[23-25]

Limitations to this study must be addressed. The population included was not diverse as the survey occurred at a single university. This may limit generalizability to other ethnicities and universities in other geographical areas as their experience

and perceptions could be different. The survey was designed to minimize fatigue, which limited the number of questions that were asked. Therefore, we did not obtain detailed vaping history with which products were being used, duration of vaping, or number of vape uses. These details would have better described the participant history and may have identified confounding variables. The survey was deployed in the fall of 2018, which was before flavor bans and reports of -EVALI. The survey did not ask if e-cigarette users were using the device as a cessation aid, which could impact their perception of the devices. Finally, the standard definition of e-cigarette use was one time, which may have led to higher prevalence compared to the other tobacco products which require 20-100 times to be considered past use.

In conclusion, this sample of college students demonstrated high use of e-cigarettes. Overall, current and past e-cigarette users perceived the products to be less harmful compared to never users. Additional research should be done to see how perceptions and use of e-cigarettes have changed considering lung injury reports and increased regulations.

REFERENCES

1. Centers for Disease Control and Prevention. *Electronic cigarettes: What's the bottom line? Smoking and Tobacco Use*; 2018. https://www.cdc.gov/tobacco/basic_information/e-cigarettes/pdfs/Electronic-Cigarettes-Infographic-508.pdf
2. Schulenberg JE, Patrick ME, Johnston LD., O'Malley PM, Bachman JG, Miech RA. *Monitoring the future national survey results on drug use, 1975–2020: Volume II, College students and adults ages 19–60*. Ann Arbor: Institute for Social Research, The University of Michigan. https://monitoringthefuture.org/wp-content/uploads/2022/08/mtf-vol2_2020.pdf (2020).
3. Tsai J, Walton K, Coleman BN, et al. Reasons for electronic cigarette use among middle and high school students—National Youth Tobacco Survey, United States, 2016. *MMWR Morb Mortal Wkly Rep*. 2018;67(6):196-200. doi:10.15585/mmwr.mm6706a5
4. González Roz A., Secades Villa R., Weidberg S.. Evaluating nicotine dependence levels in e-cigarette users. *Adicciones*. 2017;29(2):136-138. doi:10.20882/adicciones.905
5. National Academies of Sciences. Engineering, and medicine. *Public health consequences of e-cigarettes*. Washington, DC: National Academies Press. https://www.nap.edu/catalog/24952/public-health-consequences-of-e-cigarettes (2018).
6. Abbott B. *Youth marijuana vaping on the rise, researchers say*. New York: Wall Street Journal; 2019 December 18. https://www.wsj.com/articles/youth-marijuana-vaping-on-the-rise-researchers-say-11576645261
7. Cooper M, Loukas A, Case KR, Marti CN, Perry CL. A longitudinal study of risk perceptions and e-cigarette initiation among college students: Interactions with smoking status. *Drug Alcohol Depend*. 2018;186:257-263. doi:10.1016/j.drugalcdep.2017.11.027
8. Leventhal AM, Strong DR, Kirkpatrick MG, Unger JB, Sussman S, Riggs NR, Stone MD, Khoddam R, Samet JM, Audrain-McGovern J. Association of electronic cigarette use with initiation of combustible tobacco product smoking in early adolescence. *JAMA*. 2015;314(7):700-707. doi:10.1001/jama.2015.8950
9. McKelvey K, Baiocchi M, Halpern-Felsher B. Adolescents' and young adults' use and perceptions of pod-based electronic cigarettes. *JAMA Netw Open*. 2018;1(6): e183535. doi:10.1001/jamanetworkopen.2018.3535
10. The link between marijuana and e-cigarettes. (2019). Retrieved from. https://truthinitiative.org/research-resources/substance-use/link-between-marijuana-and-e-cigarettes?utm_source=Truth+Initiative+Mailing+List&utm_campaign=cb88894dee-Newsletter_178_2019_12_05&utm_medium=email&utm_term=0_c91fd8a5c5-cb88894dee-86477767. Accessed December 6, 2019
11. U.S. Surgeon General. Know the risks: E-cigarettes & young people: U.S. surgeon general's report. Know the risks: E-cigarettes and young people|U.S. surgeon general's report. 2016. Retrieved from. https://e-cigarettes.surgeongeneral.gov/default.htm https://e-cigarettes.surgeongeneral.gov/default.htm. Accessed January 2, 2019
12. Vogel EA, Prochaska JJ, Ramo DE, Andres J, Rubinstein ML. Adolescents' e-cigarette use: increases in frequency, dependence, and nicotine exposure over 12 months. *J Adolesc Health*. 2019;64(6):770-775. doi:10.1016/j.jadohealth.2019.02.019
13. Clapp PW, Jaspers I. Electronic cigarettes: Their constituents and potential links to asthma. *Curr Allergy Asthma Rep*. 2017;17(11):79. doi:10.1007/s11882-017-0747-5
14. Lee WH, Ong S-G, Zhou Y, Tian L, Bae HR, Baker N, Whitlatch A, Mohammadi L, Guo H, Nadeau KC, Springer ML, Schick SF, Bhatnagar A, Wu JC. Modeling cardiovascular risks of e-cigarettes with human-induced pluripotent stem cell–derived endothelial cells. *J Am Coll Cardiol*. 2019;73(21):2722-2737. doi:10.1016/j.jacc.2019.03.476
15. Wang TW, Gentzke A, Sharapova S, Cullen KA, Ambrose BK, Jamal A. Tobacco product use among middle and high school students—United States, 2011–2017. *MMWR Morb Mortal Wkly Rep*. 2018;67(22):629-633. doi:10.15585/mmwr.mm6722a3
16. Weaver SR, Kim H, Glasser AM, Sutfin EL, Barrington-Trimis J, Payne TJ, Saddleson M, Loukas A. Establishing consensus on survey measures for electronic nicotine and non-nicotine delivery system use: Current challenges and considerations for researchers. *Addict Behav*. 2018;79:203-212. doi:10.1016/j.addbeh.2017.11.016
17. Gibson LA, Creamer MR, Breland AB, Giachello AL, Kaufman A, Kong G, Pechacek TF, Pepper JK, Soule EK, Halpern-Felsher B. Measuring perceptions related to e-cigarettes: Important principles and next steps to enhance study validity. *Addict Behav*. 2018;79:219-225. doi:10.1016/j.addbeh.2017.11.017
18. Health. Smoking and tobacco use; data and statistics; surveys; national youth tobacco survey (NYTS). Smoking and tobacco use; (2018, May 9). https://www.cdc.gov/tobacco/data_statistics/surveys/nyts/
19. Franks AM, Hawes WA, McCain KR, Payakachat N. Electronic cigarette use, knowledge, and perceptions among health professional students. *Curr Pharm Teach Learn*. 2017;9(6):1003-1009. doi:10.1016/j.cptl.2017.07.023
20. Wackowski OA, Sontag JM, Hammond D, O'Connor RJ, Ohman-Strickland PA, Strasser AA, Villanti AC, Delnevo CD. The impact of e-cigarette warnings, warning themes and inclusion of relative harm statements on young adults' e-cigarette perceptions and use intentions. *Int J Environ Res Public Health*. 2019;16(2): 184. doi:10.3390/ijerph16020184
21. Wood GG, Waselewski ME, Bryant AC, Sonneville KR, Chang T. Youth perceptions of juul in the United States. *JAMA Pediatr*. 2020;174:800-802. doi:10.1001/jamapediatrics.2020.0491
22. McKelvey K, Halpern-Felsher B. How and why california young adults are using different brands of pod-type electronic cigarettes in 2019: Implications for researchers and regulators. *J Adolesc Health*. 2020;67(1):46-52. doi:10.1016/j.jadohealth.2020.01.017
23. Schiff S., Liu F, Cruz TB, et al. E-cigarette and cigarette purchasing among young adults before and after implementation of California's tobacco 21 policy. *Tob Control*. 2021;30(2):206-211. http://orcid.org/0000-0001-9745-7952
24. Roberts ME, Keller-Hamilton B, Teferra AA. Tobacco 21's impact amid the e-cigarette surge. *Public Health Rep*. 2023;138(1):62-67. doi:10.1177/00333549211061772
25. Siegel M, Katchmar A. Effect of flavored e-cigarette bans in the United States: What does the evidence show? *Prev Med*. 2022;165(Pt B):107063. doi:10.1016/j.ypmed.2022.107063