VAPING: PREDICTORS OF ACTUAL AND PERCEIVED E-CIGARETTES USE BEHAVIOR AMONG U.S. COLLEGE STUDENTS

A Thesis

by

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ABSTRACT

Vaping – the use of electronic cigarettes - is an emerging health problem among college students. Between 2017 to 2018, past 30-day vaping of nicotine or marijuana increased from 6.1% to 15.5%, and from 5.2% to 10.9%, respectively. This research assessed demographic and behavioral correlates associated with actual and perceived use of e-cigarettes among college students participating in the National College Health Assessment (NCHA). Respondents (n = 19,861) comprised undergraduate and graduate college students across more than 40 distinct public and private institutions of higher education. Past month frequency of use was established for alcohol, tobacco, marijuana, and e-cigarettes (ATME). Additionally, the perceived use of ATME by the 'typical student' at each institution was assessed. Current users (vaped within past 30 days) were compared to non-users (never used, and previously vaped but not in the past 30 days). Multivariable logistic regression was used to assess (1) whether alcohol, tobacco or marijuana use were associated with the use of e-cigarettes; and (2) whether perceived use of alcohol, tobacco or marijuana by typical students were associated with perceived use of e-cigarettes, above and beyond the influence of several covariates (e.g., age, gender, race, year in school, current residence, Greek membership).

Approximately 5% of survey respondents self-reported that they were current e-cigarette users. More than 7 out of every 10 respondents, however, thought the 'typical student' on their campus was an e-cigarette user. Male students (OR=2.28, $p<0.01$) were at higher odds of vaping compared to females. Exposure-response relationships among cigarettes, alcohol, and marijuana users were present, such that the likelihood of current vaping increased significantly as use of these substances increased. Similarly, as perceptions of typical student substance use increased, respondents were far more likely to contend the typical student used e-cigarettes.

Results highlight the need for development and implementation of effective policies to manage vaping and substance use among students, and to mitigate peer pressure and social influences for the use of e-cigarettes on college campuses should be a priority for university management. Given students perceived that the typical student vaped, it would be important for future work to assess the relationship between self-vaping behaviors and perceptions of vaping behavior among peers. We recommend university administrations seek to adopt effective and system-wide smoke-free and tobacco-free campus policies.

DEDICATION

To my beloved parents, family, and friends

To my respected teachers

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NOMENCLATURE

ACHA	American College Health Association
ANRF	American Nonsmokers' Rights Foundation
ATME	Alcohol, Tobacco, Marijuana, and E-Cigarettes
CBD	Cannabidiol
CDC	Centers for Disease Control and Prevention
CI	Confidence Interval
ENDS	Electronic Nicotine Delivery Systems
EVALI	E-cigarette, or Vaping, Product Use-Associated Lung Injury
FDA	U.S. Food and Drug Administration
HHS	United States Department of Health and Human Services
IRB	Institutional Review Board
NCHA	National College Health Assessment
OR	Odds Ratio
OSUE	Other Substance Use in E-cigarettes
THC	Tetrahydrocannabinol

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Contributors

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TABLE OF CONTENTS

LIST OF FIGURES

FIGURE Page

LIST OF TABLES

TABLE Page

CHAPTER I

INTRODUCTION[*]

Problem Statement

Vaping, or e-cigarette use, represents a timely, significant public health issue among adolescents and young adults (U.S. Department of Health and Human Services, 2016; Surgeon General Advisory, 2018; Murthy, 2017; Cullen et al., 2019; Vallone et al., 2019; Walley et al., 2019; Hammond et al., 2020; King et al., 2020). As of February 18, 2020, the Centers for Disease Control and Prevention (2020) have reported 2,807 hospitalized cases and 68 deaths attributed to *'e-cigarette, or vaping, product use associated lung injury (EVALI)'* (CDC, 2020). Electronic cigarettes, e-liquids, personal vaporizers, vaping devices, vape pens, e-hookahs, e-cigars, electronic pipes, and mod systems or pod systems, represent popular electronic nicotine delivery systems (ENDS) among the U.S. youth (U.S. Food and Drug Administration, 2020). Use of ENDS is also associated with alcohol, tobacco, marijuana, and other legal and illegal drugs as well as exposure to secondhand aerosol (American Academy of Pediatrics, 2015; Temple et al., 2017; Trivers et al., 2018; Dai, 2020; Park et al., 2020). A wide variety of available flavors combined with nicotine addictiveness are two primary reasons for the rapid growth of the e-cigarette market and rise in popularity among youth and young adults (U.S. Department of Health and Human Services, 2016; Surgeon General Advisory, 2018; U.S. Food and Drug Administration, 2020).

[*]Parts of this chapter are adapted with permission from (American Nonsmokers' Rights Foundation, 2019) and (Public Health Law Center, 2019).

Study Purpose

This investigation sought to explore e-cigarette use among a national sample of U.S. college students. Specifically, utilizing the National College Health Assessment Survey (Fall 2015), a secondary data source, we assessed demographic and behavioral correlates, including the co-use of other substances, associated with actual personal use and perceived peer use of e-cigarettes. Most existing literature focuses on individual predictors for using e-cigarettes, but our study, identifies and compares risk factors for both actual and perceived vaping behavior among U.S. college students. An enhanced understanding of such factors is important considering vaping is a growing trend among American youth and young adults (Murthy, 2017; Cullen et al., 2018; King et al., 2018; Huang et al., 2019; Cullen et al., 2019; Willett et al., 2019; Vallone et al., 2020).

Significance

The recent national outbreak among the population manifests significant public health concerns, such as lung injuries and deaths, which was related to vaping products and primarily associated with cannabis extracts. Although the CDC and FDA recently relaxed recommended vaping restrictions, however, this episode highlights the importance of understanding causal factors influencing e-cigarette use among the youth and young adults population (Centers for Disease Control and Prevention, 2020; U.S. Food and Drug Administration, 2020).

Smoking Policies in College and University Campuses

Blake and colleagues (2019) assert that initiation of smoking appears in the ages of adolescence and young adulthood and this pattern of behavior can become habitual later in life. They suggested evidence from two independent research where a study found that about 99% of

adult tobacco smokers, initiated smoking before the age of 26 years. Also, the other study identified that 87% of conventional cigarette smokers started off with smoking before the age of 24 years (Wang et al., 2018; Blake et al., 2019). Therefore, evidence-based, systematized and methodical approaches are critical to implement effective smoke-free and tobacco-free policies in colleges and universities of the United States. Practical application of the findings of the best available current public health research, scientific evidence and ideas can assist in mitigating the prevalence of usage of electronic cigarettes, secondhand smoke exposure, tobacco product initiation, marijuana habituation, and personal and social acceptance of smoking and substance use behavior between college-going youth and young adults. In 2017, around 2,082 college and university campuses approved smoke-free policies in the U.S., which was practically twice than in 2012. Among these academic campuses, 1,743 (83.7%) administered tobacco-free policies, 1,658 (79.6%) more specifically prohibited usage of vaporizers, e-cigarettes, and other electronic nicotine delivery systems, and 854 (41.0%) enforced policies that prohibited hookah smoking in college campus sites (Wang et al., 2018). In recent years, smoking laws associated with functional smoke-free and tobacco-free protections, campus health, student health care services and environmental health and safety policies have increased and improved over time among colleges and universities in the U.S., particularly on the state level. Blake and colleagues (2019), analyzed data on integrated postsecondary higher education institutions reporting to National Center for Education Statistics. The objective of this research was to investigate and report the number and proportion of accredited, and degree-granting institutions that enacted 100% smoke-free and 100% tobacco-free policies across the United States including nationally, by state and territories. Also, they examined the number of college students, faculty and staff, those who were protected by campus policies and state laws. Results estimate, in 2017, there were 823 (16.7%) accredited, degree-granting

institutions that had either a comprehensive 100% smoke-free or 100% tobacco-free protections in place. On the national level, these accredited, degree-granting institutions represented around 1816 individual campuses, extension sites, and graduate and professional schools, where smoke-free and tobacco-free laws were adopted. Blake and researchers (2019) described that approximately 14.9 million college students (26.9%) were covered by these protections at college and university campus sites. Additionally, 8.9 million faculty and staff (25.4%) were protected by 100% smoke-free or 100% tobacco-free campus policies and state laws. However, the authors identified that only three states and two territories had 100% smoke-free or 100% tobacco-free protection policies among over half of their institutions. Moreover, four states and six territories did not have any recognized 100% smoke-free or 100% tobacco-free campus protections (Blake et al., 2019).

In contrast to conventional tobacco products, e-cigarettes are newer substances of interest that require careful attention and coordinated policy education efforts among student health services personnel and college administrators. Although significant progress has been made in past years, e-cigarette policies on college campuses are not yet entirely functional, well-constructed, and critically synchronized. Effective vaping policies on college campuses remains a high-priority objective among students to maintain healthy lifestyles and behaviors. More health promotion, education, and behavior initiatives and efforts on evaluating student use behaviors, policy awareness, and policy support can ensure that students, faculty, and staff receive the utmost benefits from comprehensive 100% smoke-free and 100% tobacco-free protections. Therefore, sustainable public health practice to monitor, promote, implement, enforce, and adoption of comprehensive smoke-free and tobacco-free policies can guide college administrators to decrease the prevalence of electronic cigarettes, tobacco product use and from the adverse health effects of secondhand smoke exposure in U.S. colleges and universities (Brown et al., 2016; Wang et al.,

2018; Blake et al., 2019). Brown and colleagues (2016), conducted an online survey among 930 college and university students, to evaluate e-cigarette use behaviors and attitudes, observed e-cigarette use on campus, awareness of campus e-cigarette policies, and policy support prohibiting e-cigarette utilization on campus premises at North Dakota. Results found that, 47.6% respondents reported about current use and 43.3% reported ever use of any vaporizers or e-cigarettes on college campus sites. Approximately 29% of survey participants documented that they observed using e-cigarettes on campus among peers in the past 30 days. Among those who had detected e-cigarette use on campus, 53.4% reported witnessing e-cigarette consumption at indoor campus spaces. About 42.3% of student respondents reported that they were not aware whether their university policy prohibited e-cigarette use on campus locations and only 25.9% correctly identified campus e-cigarette policies. Nearly two-thirds (66.2%) of college respondents were in favor for campus policies that prohibit e-cigarette use on campus grounds. Brown and researchers (2016), identified that support for campus e-cigarette policies was high between the North Dakota college students. However, awareness of school ENDS regulations, like whether e-cigarettes should incorporate in campus health policies, was low and not clearly understood by a significant number of college student respondents (Brown et al., 2016).

The American Nonsmokers' Rights Foundation (ANRF), an educational nonprofit anti-smoking advocacy organization, published a recent report, *'Smoke-Free and Tobacco-Free U.S. and Tribal Colleges and Universities'* on October 1, 2019 (American Nonsmokers' Rights Foundation, 2019). Since 2002, ANRF created and administered the *U.S. College Campus Tobacco Policies Database*© that includes campus-wide policies among public and private higher educational institutions, community colleges, vocational/technical schools, professional schools, historically black, and tribal colleges and universities in the United States. Data includes smoke-

free and tobacco-free policies, e-cigarette, hookah, and marijuana coverage. This publicly available database is a unique resource for understanding current tobacco control measures adopted by academic administrations and remains the only established national repository of tobacco restriction policies among college campuses in the United States (Wang et al., 2018).

According to ANRF (2019) data, in the United States, there are at present at least 2,467 college campus sites that are 100% smoke-free, both indoors and outdoors. Among these 100% smoke-free sites, 2,044 (82.9%) are 100% tobacco-free campus including non-combustibles/smokeless, 2,074 (84.1%) prohibit electronic cigarette use, 1,089 (44.1%) prohibit hookah use, 477 (19.3%) prohibit smoking/vaping marijuana, and 528 implement all tobacco protections to personal vehicles anywhere on campus. Thus, of these smoke-free campuses, the vast majority (84%) specifically prohibit e-cigarettes (ANRF, 2019). Hence, there is a potential need for more campuses to adopt comprehensive smoke-free and tobacco-free policies at institutions of higher learning. Also, campuses that currently do not have such policies should move to adopt them to reduce the prevalence of e-cigarettes, tobacco, and marijuana product use behavior and secondhand smoke exposure in college environments.

Table 1 provides the distribution of college and university campuses with smoke-free policies and tobacco-free policies, e-cigarette, hookah, and marijuana use coverage for the United States and territories, 2019 (See Table 1).

Table 1. Smoke-Free and Tobacco-Free Policies in Colleges and Universities — United States and Territories, 2019. (n = 2,467) Adapted with permission from (American Nonsmokers' Rights Foundation, 2019)

State/Territory	Smoke-free no.	Tobacco-free no. (%)	E-cigarettes no. (%)	Marijuana no. (%)	Hookah no. (%)
Alabama	55	43 (78.2)	37 (67.3)	12 (21.8)	12 (21.8)
Alaska	6	6 (100.0)	2 (33.3)	3 (50.0)	2 (33.3)
Arizona	44	44 (100.0)	44 (100.0)	0 (0.0)	11 (25.0)
Arkansas	66	24 (36.4)	66 (100.0)	66 (100.0)	6 (9.1)
California	154	123 (79.9)	139 (90.3)	61 (39.6)	79 (51.3)
Colorado	21	18 (85.7)	20 (95.2)	19 (90.5)	18 (85.7)
Connecticut	13	8 (61.5)	12 (92.3)	5 (38.5)	8 (61.5)
Delaware	9	9 (100.0)	9 (100.0)	1 (11.1)	8 (88.8)
Florida	106	91 (85.8)	91 (85.8)	15 (14.2)	56 (52.8)
Georgia	72	70 (97.2)	49 (68.1)	5 (6.9)	17 (23.6)
Guam	2	2 (100.0)	2 (100.0)	1 (50.0)	1 (50.0)
Hawaii	16	16 (100.0)	16 (100.0)	15 (93.8)	0 (0.0)
Idaho	17	12 (70.6)	14 (82.4)	0 (0.0)	10 (58.8)
Illinois	148	39 (26.4)	143 (96.6)	15 (10.1)	135 (91.2)
Indiana	80	75 (93.8)	68 (85.0)	5 (6.3)	32 (40.0)
Iowa	111	58 (52.3)	52 (46.8)	12 (10.8)	7 (6.3)
Kansas	40	28 (70.0)	28 (70.0)	8 (20.0)	21 (52.5)
Kentucky	90	88 (97.8)	87 (96.7)	1 (1.1)	68 (75.6)
Louisiana	96	91 (94.8)	76 (79.2)	11 (11.5)	64 (66.7)
Maine	26	26 (100.0)	25 (96.2)	2 (7.7)	2 (7.7)
Maryland	26	24 (92.3)	22 (84.6)	8 (30.8)	16 (61.5)
Massachusetts	38	19 (50.0)	29 (76.3)	16 (42.1)	10 (26.3)
Michigan	83	81 (97.6)	64 (77.1)	16 (19.3)	22 (26.5)
Minnesota	28	27 (96.4)	22 (78.6)	7 (25.0)	11 (39.3)
Mississippi	52	48 (92.3)	50 (96.2)	6 (11.5)	14 (26.9)
Missouri	62	59 (95.2)	53 (85.5)	14 (22.6)	27 (43.5)
Montana	10	10 (100.0)	10 (100.0)	3 (30.0)	8 (80.0)
Nebraska	19	19 (100.0)	18 (94.7)	4 (21.1)	7 (36.8)
Nevada	3	0 (0.0)	3 (100.0)	3 (100.0)	3 (100.0)
New Hampshire	6	4 (66.7)	4 (66.7)	2 (33.3)	2 (33.3)
New Jersey	49	28 (57.1)	33 (67.3)	5 (10.2)	0 (0.0)

Table 1 Continued

State/Territory	Smoke-free no.	Tobacco-free no. (%)	E-cigarettes no. (%)	Marijuana no. (%)	Hookah no. (%)
New Mexico	2	2 (100.0)	2 (100.0)	2 (100.0)	2 (100.0)
New York	130	111 (85.4)	119 (91.5)	22 (16.9)	92 (70.8)
North Carolina	122	117 (95.9)	105 (86.1)	6 (4.9)	56 (45.9)
North Dakota	16	16 (100.0)	14 (87.5)	4 (25.0)	3 (18.8)
N. Mariana Islands	1	1 (100.0)	1 (100.0)	0 (0.0)	0 (0.0)
Ohio	58	56 (96.6)	48 (82.8)	10 (17.2)	38 (65.5)
Oklahoma	59	59 (100.0)	57 (96.6)	16 (27.1)	26 (44.1)
Oregon	34	29 (85.3)	23 (67.6)	14 (41.2)	8 (23.5)
Pennsylvania	87	76 (87.4)	73 (83.9)	29 (33.3)	56 (64.4)
Puerto Rico	3	1 (33.3)	2 (66.7)	0 (0.0)	0 (0.0)
Rhode Island	2	2 (100.0)	2 (100.0)	0 (0.0)	1 (50.0)
South Carolina	69	64 (92.8)	65 (94.2)	8 (11.6)	37 (53.6)
South Dakota	25	21 (84.0)	5 (20.0)	0 (0.0)	4 (16.0)
Tennessee	45	40 (88.9)	45 (100.0)	4 (8.9)	3 (6.7)
Texas	91	88 (96.7)	67 (73.6)	4 (4.4)	33 (36.3)
Utah	4	4 (100.0)	3 (75.0)	2 (50.0)	2 (50.0)
Vermont	26	26 (100.0)	26 (100.0)	2 (7.7)	25 (96.2)
Virginia	6	6 (100.0)	1 (16.7)	0 (0.0)	1 (16.7)
Washington	24	23 (95.8)	23 (95.8)	12 (50.0)	15 (62.5)
West Virginia	22	22 (100.0)	21 (95.5)	0 (0.0)	7 (31.8)
Wisconsin	93	90 (96.8)	84 (90.3)	1 (1.1)	3 (3.2)
Wyoming	NA	NA	NA	NA	NA
American Samoa	NA	NA	NA	NA	NA
Marshall Islands	NA	NA	NA	NA	NA
Micronesia	NA	NA	NA	NA	NA
Palau	NA	NA	NA	NA	NA
Virgin Islands	NA	NA	NA	NA	NA
District of Columbia	NA	NA	NA	NA	NA
Total	2467	2044 (82.9)	2074 (84.1)	477 (19.3)	1089 (44.1)

Note:

- NA = Not Available
- Percentage = Calculated as a subset or percentage of smoke-free college campuses

- Classification of college and university campuses with smoke-free policies, and campuses with additional policies coverage such as tobacco-free policies, policies explicitly prohibiting the use of electronic nicotine delivery systems (ENDS), smoking/vaping marijuana and hookah smoking anywhere on campus.
- College and university campuses include single or multi-campus educational systems, with or without adoption of centralized or own policies, and hence, counted individually as a separate educational entity during the calculation.

Tables 2, 3, and 4 provide a snapshot of state policies (including Washington, D.C.) of e-cigarette regulation from the perspective of minimum legal sales age, license requirements for retail shops and excise, or special taxation associated with electronic cigarettes and vaping product (See Tables 2, 3 and 4).

Table 2. States with Minimum Legal Sales Age Laws to Acquire and Purchase Electronic Cigarettes and Vaping Products - United States, 2019. (n = 50) Adapted with permission from (Public Health Law Center, 2019)

Minimum Legal Sales Age	N	State
18-year	27	Arizona, Colorado, Florida, Georgia, Idaho, Indiana, Iowa, Kansas, Kentucky, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Montana, Nevada, New Mexico, North Carolina, North Dakota, Oklahoma, Rhode Island, South Carolina, South Dakota, Tennessee, West Virginia, Wisconsin, Wyoming
19-year	5	Alabama, Alaska, Nebraska, New Hampshire, Utah
21-year	18 and D.C.	Arkansas, California, Connecticut, Delaware, Hawaii, Illinois, Maine, Maryland, Massachusetts, New Jersey, New York, Ohio, Oregon, Pennsylvania, Texas, Vermont, Virginia, Washington, and District of Columbia

Note:

- States with laws restricting youth access to e-cigarettes/ENDS enacted as of December 15, 2019.
- On December 20, 2019, the current President of the United States, Donald Trump and his administration announced raising the federal minimum age of sale of tobacco products for retailers, from 18 to 21 years.

Table 3. States with Laws that Imposed License Requirements for Retailers Including Over-The-Counter, Vending Machines, and Online Sales of Electronic Cigarettes - United States, 2019. (n = 50) Adapted with permission from (Public Health Law Center, 2019)

License Required	N	State
Yes	27 and D.C.	Alabama, Alaska, Arkansas, California, Connecticut, Hawaii, Indiana, Iowa, Kansas, Louisiana, Maine, Maryland, Massachusetts, Minnesota, Missouri, Montana, Nebraska, Nevada, New Hampshire, New York, Ohio, Pennsylvania, Rhode Island, Texas, Utah, Vermont, Washington and District of Columbia
No	23	Arizona, Colorado, Delaware, Florida, Georgia, Idaho, Illinois, Kentucky, Michigan, Mississippi, New Jersey, New Mexico, North Carolina, North Dakota, Oklahoma, Oregon, South Carolina, South Dakota, Tennessee, Virginia, West Virginia, Wisconsin, Wyoming

Note:

- States with laws requiring compulsory licenses for retail sales of e-cigarettes enacted as of December 15, 2019, and included associated policy for over-the-counter, vending machines, and/or online sales.

Table 4. States with Laws that Imposed Excise or Special Taxes on Electronic Cigarettes and Vaping Products – United States, 2019. (n = 50) Adapted with permission from (Public Health Law Center, 2019)

Excise or Special Tax	N	State
Yes	21 and D.C.	California, Connecticut, Delaware, Illinois, Kansas, Louisiana, Maine, Massachusetts, Minnesota, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Pennsylvania, Vermont, Washington, West Virginia, Wisconsin and District of Columbia
No	29	Alabama, Alaska, Arizona, Arkansas, Colorado, Florida, Georgia, Hawaii, Idaho, Indiana, Iowa, Kentucky, Maryland, Michigan, Mississippi, Missouri, Montana, Nebraska, North Dakota, Oklahoma, Oregon, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, Wyoming

Note:

- Currently, there is no federal tax on e-cigarettes and accompanying vaping product accessories.
- States with laws relevant for the purpose of taxing e-cigarettes enacted as of December 15, 2019.

CHAPTER II

LITERATURE REVIEW

E-Cigarette Use Among College Students

College students in the United States, in particular, have been recognized as a high-risk population for vaping. Prevalence of e-cigarette use is exponentially on the rise, and major e-cigarette brands, such as Juul, are increasingly gaining popularity among college students (Littlefield et al., 2015; Copeland et al., 2017; Ickes et al., 2019; Leavens et al., 2019; Wong et al., 2019; Case et al., 2020; Dobbs et al., 2020; Roberts et al., 2020). According to data from the Monitoring the Future (MTF, 2018) study, rates of vaping nicotine and vaping marijuana among college students doubled from 2017 to 2018. Specifically, from 2017 to 2018, the 30-day prevalence of vaping nicotine increased from 6.1% to 15.5%, and the 30-day prevalence of vaping marijuana rose from 5.2% to 10.9% (Monitoring the Future, 2018).

Vaping or e-cigarettes have associated with the gateway drug theory. The usage of electronic cigarettes leads to nicotine use and dependence in adolescents. It increases inhalation feelings and gestures in non-smokers, and there is a likelihood of contact with social smokers and users of other licit and illicit drugs. Thus, electronic cigarettes are claimed to have gateway effects of smoking initiation among adolescents and young adults. Nonsmoking young adult college students reported multiple reasons such as the ability to share cigarettes with other peer groups, psychological coping, cost and accessibility, leadership, sociocultural domination, behavioral patterns, and sensory effects of cigarette smoking as primary grounds for the transition from electronic cigarette use to cigarette smoking initiation (Etter, 2018; Hiler et al., 2020). While increased use of e-cigarettes among college students, in and of itself, is concerning, more than half

(55%) of current college-aged ENDS users stated that they were also simultaneously using conventional tobacco products (Littlefield et al., 2015). Among college students, there is a greater acceptance rate of use and perception of electronic cigarettes in public in comparison to smoking conventional cigarettes (Trumbo & Harper, 2013).

Thus, a large contingent of college students represents "dual users," individuals who concurrently use tobacco cigarettes and electronic cigarettes. Dual-use undergraduate college students have longer smoking histories compared to regular tobacco smokers. Dual users also are more likely to exhibit higher frequencies of past quit attempts than other smoking groups (Peltier et al., 2019). Lee et al. (2017) found that electronic cigarette use was a negative predictor of smoking cessation attempts, and college students were less motivated to use e-cigarettes as a tool for the cessation of combustible cigarettes. Moreover, dual-use college students have endorsed higher levels of positive smoking expectancies in contrast to regular smokers who use traditional cigarette products. Compared to non-users, dual users reported lower perceived harm and addictiveness of e-cigarettes and cigarettes. Therefore, among college students, dual-use was associated to higher utilization of traditional tobacco cigarettes and e-cigarettes, and subsequently, nicotine dependence was related to excessive rates of heavy episodic drinking (Littlefield et al., 2015; Lee et al., 2017; Cooper et al., 2017; Peltier et al., 2019; Harrell et al., 2019).

Multiple-product usage (i.e., tobacco and e-cigarette use) has been identified as more socially acceptable among college students compared to single tobacco product use, especially for men and older students. When cigarettes and at least one alternative tobacco products were used, the most common combinations were cigarette + e-cigarette (21.7%), cigarette + e-cigarette + hookah (17.6%), cigarette + hookah (12.2%), and cigarette + cigar (11.7%) (Loukas et al., 2016).

Sutfin et al. (2015) studied first-semester college students enrolled at one of eleven colleges in North Carolina and Virginia from 2010 to 2013 who were baseline cigarette smokers with no previous history of e-cigarettes use data. The authors observed that 43.5% of participants tried electronic cigarettes within the survey period. The primary reasons for trying electronic cigarettes included curiosity about vaporizers (91.6%), followed by exposure to friends who use e-cigarettes (70.2%), perceptions of relatively safety compared to smoking cigarettes (69.9%), absence of odor (50%), ability to use where cigarette smoking is not authorized (50%), to reduce frequency of cigarette use (30.8%), or to assist as a smoking prevention and cessation tool (20.2%). From these results, the authors surmised that trying e-cigarettes at college did not necessarily discourage student members from cigarette smoking and was more likely provided an acceptable accommodation for persistent smoking (Sutfin et al., 2015).

There are several determinants believed to be responsible for encouraging e-cigarette use and acceptability at college. Many ENDS devices marketed with unique identifying features, such as shape, size, and color. These products substantially vary in construction, containing nicotine cartridges, e-liquids, flavorings, atomizers, battery, heating element, power source, pressure switch, LED light, and programmable software (Cobb and Abrams, 2011; U.S. Food and Drug Administration, 2020). The majority of college students agree that availability of flavors and USB rechargeability enhance the overall attractiveness of e-cigarettes and encourage peers to experiment with e-cigarettes regardless of their smoking status. Appearance and positive sensory experiences are influential factors for making e-cigarettes more acceptable and appealing to college students (Harrell et al., 2017; Lee et al., 2017; Luzius et al., 2019; Katz et al., 2019).

A longitudinal assessment of 3757 college students identified that e-cigarette use was associated with the onset of cigarette smoking. Current and ever e-cigarette use raised non-smokers

chances of trying tobacco cigarettes between college/university students. Moreover, the same study asserts that, male respondents and marijuana users were at a higher likelihood to initiate e-cigarette use than other college students (Spindle et al., 2017).

Among twenty-four Texas colleges, Agarwal et al. (2018) conducted a three-wave online survey to study the roles of students' social environment, normative beliefs, and attitudes in subsequent e-cigarettes initiation in 2,110 college participants. The authors find that certain factors, such as younger adults those ever used other tobacco products, a denser college campus environment including more peer network of e-cigarettes users, denser household use by family members, higher social acceptability of electronic smoking devices, and greater propensity to date someone who uses electronic nicotine delivery systems, all seemingly contribute to future vaping initiation between 18-29 years aged college students, across one year follow up period (Agarwal et al., 2018).

Wallace and Roche (2018) administered a survey between 175 university students to evaluate if the social status and peer influence, number of friendships, and leadership skills among classmates impact the usage of e-cigarettes on college campuses. The authors identified that college students who had more friends and allies, those physically and mentally dependent on vaping, were positively linked with being offered an electronic cigarette, had increased likelihood of obtaining a future smoking offer and developed subsequent nicotine addiction (Wallace and Roche, 2018). Furthermore, using the socio-ecological model, Cheney and colleagues (2018) identified that parents, campus policy, organization, community messaging, community member requests, respect for others, and the physical, social, and environmental surroundings of campus venue influence on college students' vaping behavior (Cheney et al., 2018).

The most commonly identified reasons for college student electronic cigarette use include: curiosity (46.5%), peer pressure (21.9%), recreation (7.4%), flavors (13.3%), better than cigarettes (16.0%), and to quit/reduce tobacco use (10.1%) (Luzius et al., 2019). Saddleson et al. (2016), assert that the vast majority of current (past 30-day) college students (72.1%) report 'using for enjoyment' as the primary reason related to usage of e-cigarettes (Saddleson et al., 2016).

Co-Use of E-Cigarettes Along with Alcohol, Tobacco, and Marijuana

In addition to being correlated with tobacco use, e-cigarette consumption is also linked to alcohol and marijuana use (Sutfin et al., 2013; Berg et al., 2015; Littlefield et al., 2015; Saddleson et al., 2015; Noland et al., 2016; Milicic et al., 2017; Kenne et al., 2016 & 2017; Buu et al., 2019; Wong et al., 2019; Dobbs et al., 2020; Roys et al., 2020). Alcohol consumption, especially among students who engage in heavy episodic drinking (binge drinking), has been identified as a correlate to e-cigarettes use (Littlefield et al., 2015; Saddleson et al., 2015; Hefner et al., 2019). There is also growing prevalence of using marijuana via ENDS, with a large proportion of users asserting vaping cannabis and mixed marijuana or marijuana derivatives (77.9%) like butane hash oil, hashish, dabs, wax, THC in e-cigarettes, followed by unreported (16.4%), hookah (1.9%), herbs and supplements (1.9%), and other illicit drugs (1.9%) (Kenne et al., 2017). Among U.S. college students, alcohol drinking was associated with increased likelihood of cannabis-vaping behavior and knowledge, such as cannabis vape-pen use (Frohe et al., 2018).

Individual differences, psychological factors, and personality associated with substance misusing culture have strong influences on vaping behavior among college students. After studying a sample of 380 college participants, one of the strongest predictors of ENDS usages is current tobacco smoking behaviors (i.e., number of cigarettes smoked) (Hittner et al., 2020).

Among college undergraduates, there are high prevalence of e-cigarette use, specifically, involving a major market brand identity, known as Juul (Roberts et al., 2020). The vast majority of college students (82%) are aware of Juul (the most popular e-cigarette brand), and nearly 4 out of 10 (36%) report ever use, while 21% have used it in the past 30 days. Major risk factors for current Juul usage include being a male college student, White/non-Hispanic, younger, lower undergraduate, and being a current cigarette smoker. As a matter of fact, current conventional cigarettes smoker were about 20 times more likely to use Juul (Ickes et al., 2019).

Approximately half (49.8%) of the university's online survey participant pool (at least 18 years old adults), declared that they would inform all five of their five closest friends about using JUUL vaping products and believe that all of their peers would support this trendy and overwhelmingly fashionable behavior. The majority of participants (47.7%) documented using JUUL once or twice, and nearly one-third (29.6%) of them reported habituation to JUUL on a daily or monthly schedule (Leavens et al., 2019). JUUL and other accessible e-cigarettes generally have higher concentrations of nicotine than standard cigarettes. A comparative toxicological study examined nicotine concentrations between major electronic cigarette products of the market. The results of this chemical experiment demonstrate that the average concentration of nicotine was exceptionally higher in JUUL (59.2−66.7 mg/mL) compared to other ENDS products. Also, some JUUL flavor pods, fluids, and aerosols have high concentrations of flavor chemicals that could be appealing to young adults and provoke them for chronic exposure (Omaiye et al., 2019).

In an event of incoming student orientation sessions, Bourdon and Hancock (2019) utilized *'electronic audience response technology'* (such as clickers, cell phone polling devices) at seven different college campuses to track first-year college students' substance use trends, e-cigarette habits, use, and knowledge of JUUL, and attitude toward traditional cigarettes. Audience response

technology is a reliable and legitimate method of collecting anonymous and less error-prone data. It operates instantly and efficiently to maximize participants and can be used in detecting e-cigarette predictors among college students. The authors found that most first-year student participants (67.3%) were aware that JUUL e-cigarette devices always contained nicotine. However, a major share of incoming college students was not well informed that JUUL e-cigarette products always contain nicotine. Among college freshmen, 30.1% assumed that it contains nicotine and/or just flavor, and 2.1% understood that it only carried flavored vapor. Bourdon and Hancock (2019) believe, data from electronic audience response technologies could be used by public health researchers, counseling psychologists and college health professionals for rapid assessment of electronic cigarette trends, identifying target population, and screen students who are thought to be at a greater risk of nicotine addiction and other substance use behaviors across U.S. college campuses (Bourdon and Hancock, 2019).

Marijuana/cannabis is a prevalent substance of choice used in electronic nicotine delivery systems. Young adults utilize various forms of cannabinoids such as tetrahydrocannabinol (THC), cannabidiol (CBD), oily THC extracts (hash oil/butane honey oil or BHO) in inhalation method. Many of them perceive that using electronic cigarettes with a combination of e-liquids and vaporizing cannabinoids at lower temperatures is a safe and healthy practice. The reason for this belief is that vaporized cannabis creates lesser proportions of harmful toxic materials, whereas the combustion of traditional tobacco cigarettes with marijuana in higher temperatures induces damaging substances. Additionally, many home-made and commercially available THC, CBD, and marijuana oil are odorless; hence, young adults could conveniently use these products with e-cigarettes, either at home, campuses, or in public spaces with minimal annoyance and a lower chance of detection from authority figures such as police, colleagues, parents, guardians, and

teachers. Therefore, vaping behavior may contribute to a modern gateway for using marijuana between adolescence and impact environmental health through secondary exposure and passive contamination (Giroud et al., 2015). A study between 10,000 young adult students at two universities in the Southeastern United States identified that, among e-cigarette users, there were increased rates of concurrent product use behaviors (i.e., marijuana, hookah, and electronic cigarettes) (Berg et al., 2015).

Among data from 482 college students at a large southwestern university, Jones and colleagues (2016) determined that, about 30% of all research participants had vaped nicotine, and 23% had vaped cannabis in the previous year. In terms of gender, men were more routinely vaping marijuana, compared to female respondents. Caucasian and Hispanic college respondents had a higher prevalence of vaping cannabis than African American, Asian, and other racial groups of students. Frequency of polysubstance use, such as tobacco cigarettes, nicotine vaping, marijuana, alcohol consumption, binge drinking, and other types of illicit drug use such as cocaine and amphetamines, were associated with vaping cannabis among young adult participants (Jones et al., 2016). In contrast to females and other racial and ethnic groups, male and white college students with a history of frequent alcohol and illicit drug consumption, were more likely to report concurrent and simultaneous use of cannabis as well as both combustible and electronic cigarettes (Ruglass et al., 2019). In most cases, college students used e-cigarettes when other substances such as conventional tobacco products, marijuana, and alcohol were present during various socializing purposes, friendly events and community gatherings (Saddleson et al., 2015; Buu et al., 2019).

Demographic Correlates Associated with E-Cigarette Use Among College Students

Younger students perceived lower harm about vaping and demonstrated higher odds of current use or ever use of e-cigarettes (Sutfin et al., 2013; Saddleson et al., 2015; Hiler et al., 2020).

In respect to gender, being a male college student is a significant risk factor for current e-cigarette use than females (Sutfin et al., 2013; Littlefield et al., 2015; Saddleson et al., 2015; Noland et al., 2016; Spindle et al., 2017; Ickes et al., 2019; Hittner et al., 2020). A study suggests, among college students, in comparison with women (43.0%), men (57.0%) were more likely to report about an increasing trend of other substance use, other than nicotine, in e-cigarettes (OSUE) (Kenne et al., 2017). E-cigarette use was more likely linked to Non-Hispanic Whites compared to Hispanic or other race and ethnicity student groups (Sutfin et al., 2013; Saddleson et al., 2015; Ickes et al., 2019; Roberts et al., 2020). Kenne et al. (2017) identified that white (93.5%) student respondents significantly reported in connection with other substance use in e-cigarettes (OSUE) than African Americans and the general student population of the university (Kenne et al., 2017). However, a few studies did not observe any firm statistical association between college student e-cigarette use and race/ethnicity (Littlefield et al., 2015). Lower undergraduate college students were about four times more likely to be current e-cigarette users in comparison to upper undergraduates (Ickes et al., 2019). Students residing at on-campus residence locations were in a higher likelihood of using e-cigarettes compared to others who lived at off-campus housing types (Sutfin et al., 2013; Brown et al., 2016). Members of collegiate fraternity and/or sorority groups are at a higher risk of electronic cigarette use, tobacco smoking, drinking alcohol, and other substance use behaviors (Sutfin et al., 2013; Cheney et al., 2014; McCabe et al., 2018; Soule et al., 2019). Greek members appeared to be at higher risk for use of multiple tobacco products and were almost twice as likely to report cigarette smoking, waterpipe tobacco smoking, and e-cigarette use, compared to non-fraternity and non-sorority members (Soule et al., 2019).

CHAPTER III

METHODS

Data Source

This secondary data analysis examined the National College Health Assessment (NCHA) research survey data (Fall, 2015). NCHA is a nationally recognized comprehensive assessment of college student health behaviors in the U.S., organized and collected by the American College Health Association (ACHA). Data are gathered biannual (fall or spring), where respondents included randomly selected groups of undergraduate and graduate students. Participation in this survey is exclusively voluntary, and students may skip or refuse to answer any uncomfortable questions if they desire. E-mail contact information is automatically destroyed right after the submission of survey responses. Therefore, the data provided are de-identified and blinded, and no responses can be linked to individual students or academic institutions.

Currently, NCHA is administering in a web-based format, and colleges and universities determine when to participate and can self-select accordingly. Also, schools have the flexibility to choose from several alternatives, like what type of health issues to cover, survey techniques, the population of interest, sample size, and period of research. Institutional control involved both public and private settings and made up of two-year and four-year colleges, including large research universities. Public health researchers and college health administrators can request access to survey data through ACHA.

The survey comprised a wide range of college health topics such as student enrollment and demographics; perceptions about creating healthy habits; health education and preventive practices; alcohol, tobacco smoking, marijuana, other drug and substance use; weight, nutrition,

and exercise; physical and mental health; impediments to academic performance; sleep and relationship difficulties; personal safety and violence; sexual behavior, contraception, OB-GYN and teen pregnancy awareness; effectiveness of healthcare utilization for various on-campus and off-campus services among university students (American College Health Association, 2019; U.S. Department of Health and Human Services, 2019). Questions related to e-cigarette variables were first included in the Fall 2015 ACHA-NCHA survey (version IIc web survey).

Since we specifically used this research focused on the Fall 2015 semester survey data, which provides data for 19,861 respondents comprised undergraduate and graduate college students across more than 40 distinct public and private institutions of higher education. Past month frequency of use was established for alcohol, tobacco, marijuana, and e-cigarettes (ATME). In addition to the personal frequency of use, perceived use among each substance was established by having respondents estimate the use of ATME (alcohol, tobacco, marijuana, and e-cigarettes) by the "typical student" at their institution. Therefore, our present research framework is a cross-sectional study (American College Health Association, 2019). The Institutional Review Board (IRB) Administration of Texas A&M University determined that this research does not involve human subjects, on December 03, 2019.

Research Design

Our primary research objective was to assess demographic and behavioral correlates, including co-use of other substances, concerning actual personal use and perceived peer use of e-cigarettes, among a national sample of U.S. college students. We carefully choose specific covariates for all study analyses such as age, gender, year in school, race, current residence, Greek membership, and included co-use of other substances, e.g., cigarettes, alcohol, marijuana, and e-

cigarettes. Our goal is to assess (1) whether alcohol, tobacco or marijuana use were associated with the actual personal use of e-cigarettes; and (2) whether perceived use of alcohol, tobacco or marijuana by typical students was associated with perceived use of e-cigarettes, and the influence of other student characteristics (age, gender, year in school, race, current residence, Greek membership).

Variables and Measures

Outcome variables included actual personal use and perceived peer use of electronic cigarettes. Actual e-cigarette use was assessed with the following question: "Within the last 30 days, on how many days did you use E-cigarettes?" Response options included: never used, have used, but not in the last 30 days, 1-2 days, 3-5 days, 6-9 days, 10-19 days, 20-29 days, and used daily. We recoded this existing variable measure in Stata into three categories: current users (1-2 days, 3-5 days, 6-9 days, 10-19 days, 20-29 days, and used daily), ever users (have used, but not in last 30 days) and never users of e-cigarettes. Greater daily values were indicated of more frequent personal e-cigarette use among college students.

Perceived e-cigarette use was assessed with the following question: "Within the last 30 days, how often do you think the typical student at your school used E-cigarettes?" Response options included: never used, have used, but not in the last 30 days, 1-2 days, 3-5 days, 6-9 days, 10-19 days, 20-29 days, and used daily. Likewise, we recoded this existing variable measure in Stata into three categories: current users (1-2 days, 3-5 days, 6-9 days, 10-19 days, 20-29 days, and used daily), ever users (have used, but not in last 30 days) and never users of e-cigarettes. Greater daily values were indicated of more frequent perceived e-cigarette use among typical students.

Explanatory variables of interest generally fall into two broad categories: *Demographic Characteristics* (age, gender, year in school, race, current residence, Greek membership) and *Behaviors & Perceptions* (personal use of cigarettes, alcohol, and marijuana; perceived use of other substances among typical student).

Age as a variable was assessed with the following question: "How old are you?" Response options were measured in years, recoded and labeled into five distinct age groups: 18-20, 21-23, 24-26, 27-29, and 30 & above.

Gender or biological sex variable was assessed with the following question: "What sex were you assigned at birth, such as on an original birth certificate?" Response options included: female and male.

Year in school was assessed with the following question: "What is your year in school?" Response options included: 1st-year undergraduate, 2nd-year undergraduate, 3rd-year undergraduate, 4th-year undergraduate, 5th-year or more undergraduate, graduate or professional, not seeking a degree and other. We recoded options, 'not seeking a degree' and 'other' as missing values and used the rest undergraduate and graduate or professional answer responses.

Race as a variable was assessed with the following question: "How do you usually describe yourself?" Response options included: White; Black; Hispanic or Latino; Asian or Pacific Islander; American Indian, Alaskan Native, or Native Hawaiian; Biracial or Multiracial; Other. The four primary race and ethnicity variables (White, Black, Hispanic, and Asian) were combined into the mutually exclusive race and ethnicity categories, and all other responses were recoded as missing data.

The current residence variable was assessed with the following question: "Where do you currently live?" Response options were recoded and labeled into two categories of residential

facilities: on-campus (campus residence hall, fraternity or sorority house, other college/university housing) and off-campus (parent/guardian's home, other off-campus housing, other). Greek life membership (fraternities and sororities) was assessed with the following question: “Are you a member of a social fraternity or sorority? (e.g., National Interfraternity Conference, National Panhellenic Conference, National Pan-Hellenic Council, National Association of Latino Fraternal Organizations)” Response options included: no and yes. Actual cigarette use was assessed with the following question: “Within the last 30 days, on how many days did you use Cigarettes?” Response options included: never used, have used, but not in the last 30 days, 1-2 days, 3-5 days, 6-9 days, 10-19 days, 20-29 days, and used daily. We recoded this existing variable measure in Stata into three categories: current users (1-2 days, 3-5 days, 6-9 days, 10-19 days, 20-29 days, and used daily), ever users (have used, but not in last 30 days) and never users of cigarettes. Greater daily values were indicated of more frequent personal cigarette use among college students.

Actual alcohol use was assessed with the following question: “Within the last 30 days, on how many days did you use Alcohol (beer, wine, liquor)?” Response options included: never used, have used, but not in the last 30 days, 1-2 days, 3-5 days, 6-9 days, 10-19 days, 20-29 days, and used daily. We recoded this existing variable measure in Stata into three categories: current users (1-2 days, 3-5 days, 6-9 days, 10-19 days, 20-29 days, and used daily), ever users (have used, but not in last 30 days) and never users of alcohol. Greater daily values were indicated of more frequent personal alcohol use among college students. Actual marijuana use was assessed with the following question: “Within the last 30 days, on how many days did you use Marijuana (pot, weed, hashish, hash oil)?” Response options included: never used, have used, but not in the last 30 days, 1-2 days, 3-5 days, 6-9 days, 10-19 days, 20-29 days, and used daily. We recoded this existing variable measure in Stata into three categories: current users (1-2 days, 3-5 days, 6-9 days, 10-19

days, 20-29 days, and used daily), ever users (have used, but not in last 30 days) and never users of marijuana. Greater daily values were indicated of more frequent personal marijuana use among college students.

Perceived cigarette use was assessed with the following question: "Within the last 30 days, how often do you think the typical student at your school used Cigarettes?" Response options included: never used, have used, but not in the last 30 days, 1-2 days, 3-5 days, 6-9 days, 10-19 days, 20-29 days, and used daily. Likewise, we recoded this existing variable measure in Stata into three categories: current users (1-2 days, 3-5 days, 6-9 days, 10-19 days, 20-29 days, and used daily), ever users (have used, but not in last 30 days) and never users of cigarettes. Greater daily values were indicated of more frequent perceived cigarette use among typical students.

Perceived alcohol use was assessed with the following question: "Within the last 30 days, how often do you think the typical student at your school used Alcohol (beer, wine, liquor)?" Response options included: never used, have used, but not in the last 30 days, 1-2 days, 3-5 days, 6-9 days, 10-19 days, 20-29 days, and used daily. Likewise, we recoded this existing variable measure in Stata into three categories: current users (1-2 days, 3-5 days, 6-9 days, 10-19 days, 20-29 days, and used daily), ever users (have used, but not in last 30 days) and never users of alcohol. Greater daily values were indicated of more frequent perceived alcohol use among typical students. Perceived marijuana use was assessed with the following question: "Within the last 30 days, how often do you think the typical student at your school used Marijuana (pot, weed, hashish, hash oil)?" Response options included: never used, have used, but not in the last 30 days, 1-2 days, 3-5 days, 6-9 days, 10-19 days, 20-29 days, and used daily. Likewise, we recoded this existing variable measure in Stata into three categories: current users (1-2 days, 3-5 days, 6-9 days, 10-19 days, 20-29 days, and used daily), ever users (have used, but not in last 30 days) and never users of

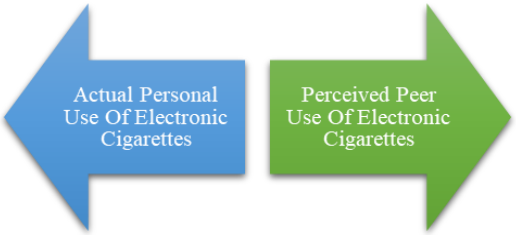
marijuana. Greater daily values were indicated of more frequent perceived marijuana use among typical students.

We examined the explanatory variables in separate descriptive statistics and multivariate logistic regression analyses models predicting actual and perceived use of electronic cigarettes. All regression models included the *Demographics* (age, gender, year in school, race, current residence, Greek membership). However, *Behaviors & Perceptions*, including co-use of other substances, varied with regard to actual personal use and perceived peer use among U.S. college students (personal use of cigarettes, alcohol, and marijuana; perceived use of other substances among typical students). In logistic regression models, we compared current vs. never users with respect to the actual and perceived use of e-cigarettes.

Figure 1 provides a general review of the dependent and independent variables that consist of demographic and behavioral correlates, including co-use of other substances such as cigarettes, alcohol, and marijuana, predicting actual and perceived use of e-cigarettes (See Figure 1).

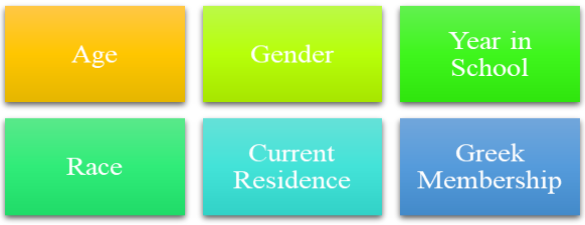
Figure 1. Variables and Measurement Involve Demographic and Behavioral Correlates, Including Co-Use of Other Substances, Assessing Actual Personal Use and Perceived Peer Use of Electronic Cigarettes. (n = 19,861) (NCHA, Fall 2015)

Outcome Variables:



Explanatory Variables:

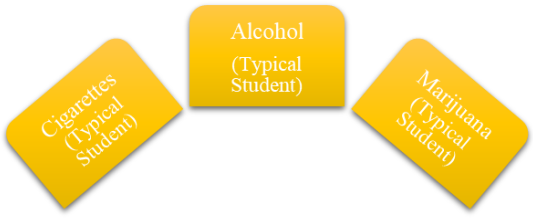
Demographics Include Both Actual and Perceived Use Behavior Among U.S. College Students:



Behaviors & Perceptions:

Actual Personal Co-Use of Other Substances:

Perceived Peer Co-Use of Other Substances:



Data Analysis

Descriptive statistics were used to characterize current users (vaped within the past 30 days), ever users (previously vaped, but not in the past 30 days), and never users of e-cigarettes, in terms of distributions of *Demographics* (age, gender, year in school, race, current residence, Greek membership) and *Behaviors & Perceptions* (personal use of cigarettes, alcohol, and marijuana; perceived use of other substances among typical student) as well as actual personal use and perceived peer use of electronic cigarettes. Two multivariable logistic regression models were calculated to assess (1) whether alcohol, tobacco or marijuana use were associated with the use of e-cigarettes; and (2) whether perceived use of alcohol, tobacco or marijuana by typical students were associated with perceived use of e-cigarettes, above and beyond the influence of several covariates (age, gender, year in school, race, current residence, Greek membership). The four primary race and ethnicity variables (White, Black, Hispanic, and Asian) are combined into the mutually exclusive race and ethnicity categories. Descriptive statistics and multivariable logistic regression analyses predicting actual and perceived use of electronic cigarettes were conducted in STATA (version 15.0) software package.

Data Flow Diagram

Figures 2 and 3 provide layouts of data flow diagrams assessing actual and perceived use of e-cigarettes (See Figures 2 and 3).

Figure 2. Data Flow Diagram Assessing Actual Use of E-Cigarettes. (n = 19,861) (NCHA, Fall 2015)

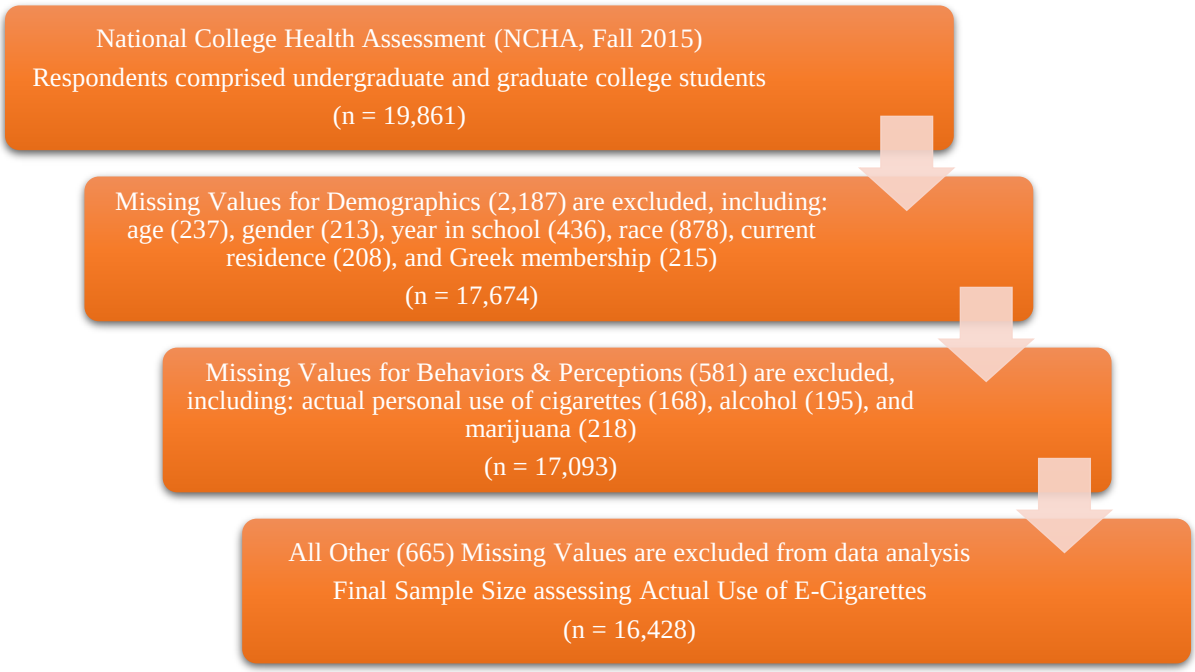
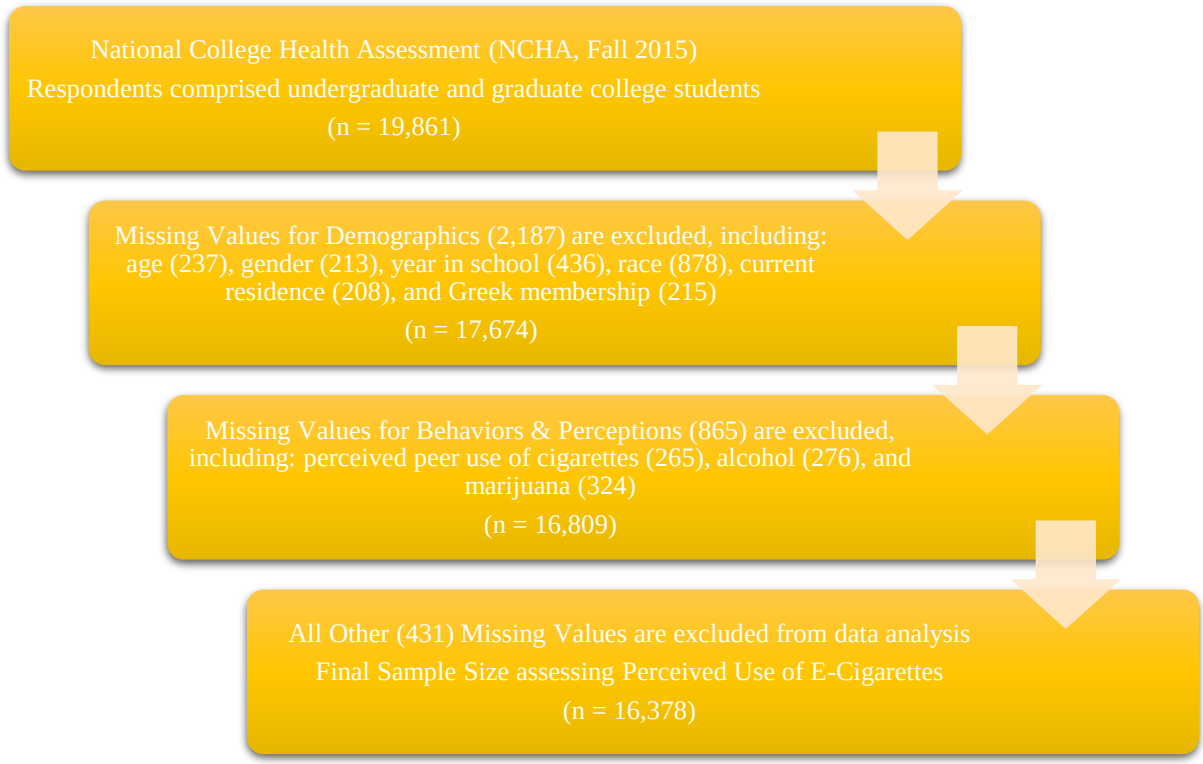


Figure 3. Data Flow Diagram Assessing Perceived Use of E-Cigarettes. (n = 19,861) (NCHA, Fall 2015)



CHAPTER IV

RESULTS

Descriptive Statistics

Approximately 4.9% were classified as current e-cigarette users, while 84.6% never used. More than 7 out of every 10 respondents thought the 'typical student' on their campus was an e-cigarette user. Between perceived users of electronic cigarettes, respondents believed that 73.7% of their peers were currently habituated to vaping, whereas 15.9% never used.

Table 10 (APPENDIX B) provides frequency and percentage distribution comparing, actual, and perceived use of e-cigarettes. Additionally, for the purpose of graphical representation of data, we constructed pie charts (Figure 4) displaying percentage distribution concerning actual and perceived use of e-cigarettes. Pie chart diagrams are designated with specific colors, where red, yellow, and green indicate current, ever, and never users, respectively. In Figure 4, approximately, current (5%), ever (11%), and never (84%), users demonstrate actual personal use of electronic cigarettes. Also, in Figure 4, approximately, current (74%), ever (10%), and never (16%), users illustrate perceived peer use of electronic cigarettes.

Figure 4 provides pie charts displaying percentage distribution of current, ever, and never users assessing actual and perceived use of e-cigarettes (See Figure 4).

Figure 4. Percentage Distribution Assessing Actual Personal Use and Perceived Peer Use of Electronic Cigarettes. (n = 19,861) (NCHA, Fall 2015)

We assessed demographic and behavioral correlates, including the co-use of other substances, concerning actual and perceived use of e-cigarettes. In descriptive statistical analysis, *Demographic Characteristics* (age, gender, year in school, race, current residence, Greek membership) and *Behaviors & Perceptions* (personal use of cigarettes, alcohol, and marijuana; perceived use of other substances among typical student), variables are used to determine the frequency and percentage distribution in connection with current, ever, and never users, assessing actual personal use and perceived peer use of electronic cigarettes.

Tables 5 and 6 provide descriptive statistics measures, including frequency and percentage distribution about current, ever, and never users, assessing actual and perceived use of e-cigarettes (See Tables 5 and 6).

Table 5. Descriptive Statistics Assessing Actual Use of Electronic Cigarettes. (n = 19,861) (NCHA, Fall 2015)

Variables	Actual Use of Electronic Cigarettes		
	Current user N (%)	Ever user N (%)	Never user N (%)
Age Groups (in years)			
18-20	583 (5.6)	1,097 (10.6)	8,693 (83.8)
21-23	198 (4.1)	551 (11.4)	4,102 (84.6)
24-26	56 (3.8)	157 (10.7)	1,249 (85.4)
27-29	29 (3.2)	102 (11.4)	768 (85.4)
30 and above	83 (4.3)	158 (8.2)	1,676 (87.4)
Gender			

Table 5 Continued

Variables	Actual Use of Electronic Cigarettes		
	Current user N (%)	Ever user N (%)	Never user N (%)
Female	471 (3.6)	1,176 (9.0)	11,392 (87.4)
Male	482 (7.4)	888 (13.7)	5,117 (78.9)
Year in School			
1st year undergraduate	317 (6.4)	446 (9.0)	4,198 (84.6)
2nd year undergraduate	202 (5.1)	484 (12.2)	3,298 (82.8)
3rd year undergraduate	194 (5.3)	425 (11.7)	3,020 (83.0)
4th year undergraduate	134 (4.5)	341 (11.5)	2,484 (84.0)
5th year or more undergraduate	49 (4.4)	170 (15.3)	891 (80.3)
Graduate or professional	52 (2.0)	185 (7.0)	2,415 (91.1)
Race Categories			
White	750 (5.3)	1,608 (11.4)	11,737 (83.3)
African-American	36 (2.6)	78 (5.7)	1,253 (91.7)
Hispanic	72 (4.3)	195 (11.7)	1,403 (84.0)
Asian	61 (3.5)	116 (6.7)	1,560 (89.8)
Current Residence			
Off-campus	524 (4.5)	1,250 (10.8)	9,797 (84.7)
On-campus	428 (5.4)	815 (10.2)	6,716 (84.4)
Social Fraternity or Sorority Membership			
No	789 (4.6)	1,738 (10.2)	14,590 (85.2)
Yes	165 (6.9)	325 (13.5)	1,918 (79.7)
Other Substance Use			
Cigarettes			
Ever used	209 (8.2)	970 (38.2)	1,362 (53.6)
1-2 days	150 (22.3)	221 (32.8)	302 (44.9)
3-5 days	71 (29.3)	70 (28.9)	101 (41.7)
6-9 days	43 (26.2)	47 (28.7)	74 (45.1)
10-19 days	62 (33.9)	43 (23.5)	78 (42.6)
20-29 days	26 (25.2)	29 (28.2)	48 (46.6)
Used daily	127 (24.1)	144 (27.3)	256 (48.6)
Never used	268 (1.8)	552 (3.6)	14,400 (94.6)
Alcohol			
Ever used	88 (3.0)	355 (12.1)	2,499 (84.9)
1-2 days	149 (4.3)	357 (10.2)	2,994 (85.5)
3-5 days	166 (5.7)	405 (13.8)	2,355 (80.5)
6-9 days	194 (7.8)	398 (15.9)	1,906 (76.3)
10-19 days	208 (10.7)	343 (17.7)	1,391 (71.6)
20-29 days	76 (12.8)	105 (17.7)	411 (69.4)
Used daily	24 (11.1)	51 (23.5)	142 (65.4)
Never used	47 (0.9)	56 (1.1)	4,906 (97.9)
Marijuana			
Ever used	247 (6.8)	828 (22.9)	2,547 (70.3)
1-2 days	110 (10.2)	231 (21.4)	737 (68.4)
3-5 days	81 (15.1)	110 (20.6)	344 (64.3)
6-9 days	60 (19.6)	76 (24.8)	170 (55.6)
10-19 days	74 (20.5)	92 (25.5)	195 (54.0)
20-29 days	57 (21.2)	76 (28.3)	136 (50.6)
Used daily	79 (20.1)	136 (34.5)	179 (45.4)
Never used	245 (1.9)	522 (4.0)	12,274 (94.1)

Table 6. Descriptive Statistics Assessing Perceived Use of Electronic Cigarettes. (n = 19,861) (NCHA, Fall 2015)

Variables	Perceived Use of Electronic Cigarettes		
	Current user N (%)	Ever user N (%)	Never user N (%)
Age Groups (in years)			
18-20	7,758 (75.1)	1,021 (9.9)	1,555 (15.1)
21-23	3,649 (75.4)	467 (9.7)	724 (15.0)
24-26	1,020 (70.5)	167 (11.5)	260 (18.0)
27-29	608 (68.5)	115 (13.0)	165 (18.6)
30 and above	1,264 (68.1)	233 (12.6)	359 (19.3)
Gender			
Female	9,852 (76.1)	1,186 (9.2)	1,904 (14.7)
Male	4,451 (69.1)	821 (12.7)	1,171 (18.2)
Year in School			
1st year undergraduate	3,659 (74.0)	489 (9.9)	794 (16.1)
2nd year undergraduate	2,905 (73.5)	408 (10.3)	642 (16.2)
3rd year undergraduate	2,779 (76.6)	320 (8.8)	527 (14.5)
4th year undergraduate	2,263 (76.7)	277 (9.4)	410 (13.9)
5th year or more undergraduate	842 (76.3)	119 (10.8)	143 (13.0)
Graduate or professional	1,719 (66.2)	363 (14.0)	516 (19.9)
Race Categories			
White	10,416 (74.4)	1,543 (11.0)	2,035 (14.5)
African-American	986 (72.8)	93 (6.9)	276 (20.4)
Hispanic	1,301 (78.0)	140 (8.4)	227 (13.6)
Asian	1,134 (65.8)	166 (9.6)	424 (24.6)
Current Residence			
Off-campus	8,453 (73.8)	1,206 (10.5)	1,801 (15.7)
On-campus	5,858 (73.9)	802 (10.1)	1,269 (16.0)
Social Fraternity or Sorority Membership			
No	12,462 (73.4)	1,764 (10.4)	2,750 (16.2)
Yes	1,850 (76.7)	242 (10.0)	319 (13.2)
Other Substance Use			
Cigarettes-typical student			
Ever used	706 (28.8)	1,328 (54.1)	419 (17.1)
1-2 days	2,372 (84.0)	256 (9.1)	197 (7.0)
3-5 days	2,639 (93.1)	90 (3.2)	107 (3.8)
6-9 days	2,142 (93.4)	71 (3.1)	81 (3.5)
10-19 days	2,307 (95.8)	44 (1.8)	58 (2.4)
20-29 days	890 (95.3)	22 (2.4)	22 (2.4)
Used daily	3,128 (95.5)	59 (1.8)	88 (2.7)
Never used	200 (8.1)	147 (5.9)	2,129 (86.0)
Alcohol-typical student			
Ever used	67 (13.3)	193 (38.3)	244 (48.4)
1-2 days	1,093 (63.6)	250 (14.5)	376 (21.9)
3-5 days	1,431 (65.7)	389 (17.9)	359 (16.5)
6-9 days	2,351 (69.8)	509 (15.1)	508 (15.1)
10-19 days	4,396 (83.1)	460 (8.7)	437 (8.3)
20-29 days	2,407 (91.2)	116 (4.4)	117 (4.4)
Used daily	2,574 (93.9)	80 (2.9)	88 (3.2)
Never used	47 (4.6)	17 (1.7)	964 (93.8)
Marijuana-typical student			
Ever used	483 (35.9)	480 (35.7)	381 (28.4)

Table 6 Continued

Variables	Perceived Use of Electronic Cigarettes		
	Current user N (%)	Ever user N (%)	Never user N (%)
1-2 days	1,813 (69.5)	441 (16.9)	356 (13.6)
3-5 days	2,114 (78.4)	323 (12.0)	261 (9.7)
6-9 days	2,547 (84.0)	276 (9.1)	209 (6.9)
10-19 days	3,087 (88.7)	220 (6.3)	174 (5.0)
20-29 days	1,677 (91.5)	95 (5.2)	60 (3.3)
Used daily	2,295 (94.6)	55 (2.3)	76 (3.1)
Never used	323 (16.0)	123 (6.1)	1,572 (77.9)

Multivariable Logistic Regression Model

We estimated multivariable logistic regression models for both actual and perceived use of electronic cigarettes. Multivariable logistic regression model results are shown in the following tables (Tables 7 and 8).

Table 7 provides multivariable logistic regression model predicting actual use of e-cigarettes (See Table 7).

Table 7. Multivariable Logistic Regression Model Predicting Actual Use of Electronic Cigarettes. (n = 19,861) (NCHA, Fall 2015)

ACTUAL USE	(1) Electronic Cigarettes (N = 16,428)	
Variables	Odds Ratio (OR)	95% Confidence Interval (CI)
Age Groups (in years)		
18-20	1.00	-
21-23	0.76*	(0.571 - 1.010)
24-26	0.72	(0.487 - 1.066)
27-29	0.66*	(0.408 - 1.069)
30 and above	0.80	(0.566 - 1.129)
Gender		
Female	1.00	-
Male	2.28***	(1.942 - 2.672)
Year in School		
1st year undergraduate	1.00	-
2nd year undergraduate	0.62***	(0.488 - 0.777)
3rd year undergraduate	0.49***	(0.377 - 0.628)
4th year undergraduate	0.43***	(0.306 - 0.607)
>4th year undergraduate	0.33***	(0.214 - 0.512)
Graduate or professional	0.15***	(0.100 - 0.232)

Table 7 Continued

ACTUAL USE Variables	(1) Electronic Cigarettes (N = 16,428) Odds Ratio (OR)	95% Confidence Interval (CI)
Race Categories		
White	1.00	-
African-American	0.49***	(0.331 - 0.721)
Hispanic	0.71**	(0.533 - 0.948)
Asian	0.92	(0.675 - 1.260)
Current Residence		
Off-campus	1.00	-
On-campus	1.00	(0.818 - 1.219)
Social Fraternity or Sorority Membership		
No	1.00	-
Yes	0.99	(0.795 - 1.244)
Other Substance Use		
Cigarettes		
Ever used	1.00	-
1-2 days	2.08***	(1.574 - 2.756)
3-5 days	3.02***	(2.051 - 4.446)
6-9 days	2.46***	(1.541 - 3.940)
10-19 days	3.34***	(2.172 - 5.142)
20-29 days	4.01***	(2.271 - 7.088)
Used daily	3.10***	(2.281 - 4.221)
Never used	0.17***	(0.134 - 0.209)
Alcohol		
Ever used	1.00	-
1-2 days	1.46**	(1.067 - 1.984)
3-5 days	1.80***	(1.316 - 2.450)
6-9 days	1.78***	(1.299 - 2.438)
10-19 days	1.84***	(1.333 - 2.539)
20-29 days	1.80***	(1.194 - 2.711)
Used daily	1.74*	(0.947 - 3.189)
Never used	0.51***	(0.339 - 0.752)
Marijuana		
Ever used	1.00	-
1-2 days	1.20	(0.901 - 1.590)
3-5 days	1.66***	(1.190 - 2.330)
6-9 days	1.59**	(1.054 - 2.384)
10-19 days	2.03***	(1.396 - 2.938)
20-29 days	2.26***	(1.488 - 3.441)
Used daily	2.21***	(1.519 - 3.216)
Never used	0.48***	(0.386 - 0.598)
Constant	0.21***	(0.150 - 0.304)

*** p<0.01, ** p<0.05, * p<0.10

The multivariable logistic regression model (Table 7) predicting actual e-cigarette use demonstrates, in terms of gender, male students (OR=2.28, $p<0.01$) were at higher odds of vaping and 2.28 times more likely to use e-cigarettes compared to females. Both undergraduates and graduate or professional students show statistically significant results, 2nd year (OR=0.62, $p<0.01$), 3rd year (OR=0.49, $p<0.01$), 4th year (OR=0.43, $p<0.01$), 5th year or more (OR=0.33, $p<0.01$) and graduate or professional (OR=0.15, $p<0.01$), however, less likely to use e-cigarettes in comparison to 1st-year undergraduates. African Americans (OR=0.49, $p<0.01$) and Hispanic/Latino (OR=0.71, $p<0.05$) student groups present statistical significance, however, less likely to use e-cigarettes compared to Whites.

Exposure-response relationships among cigarette, alcohol, and marijuana users were present, such that likelihood of current vaping increased significantly as substance use increased. Among self-reported personal cigarette smoker, current users, 1-2 days (OR=2.08, $p<0.01$); 3-5 days (OR=3.02, $p<0.01$); 6-9 days (OR=2.46, $p<0.01$); 10-19 days (OR=3.34, $p<0.01$); 20-29 days (OR=4.01, $p<0.01$) and used daily (OR=3.10, $p<0.01$) demonstrate statistical significance and positive odds relationships, hence, current users were more likely to use e-cigarettes compared to ever users. Among self-reported personal alcohol user, current users, 1-2 days (OR=1.46, $p<0.05$); 3-5 days (OR=1.80, $p<0.01$); 6-9 days (OR=1.78, $p<0.01$); 10-19 days (OR=1.84, $p<0.01$); 20-29 days (OR=1.80, $p<0.01$) and used daily (OR=1.74, $p<0.10$) demonstrate statistical significance and positive odds relationships, hence, current users were more likely to use e-cigarettes compared to ever users. Among self-reported personal marijuana user, current users, 3-5 days (OR=1.66, $p<0.01$); 6-9 days (OR=1.59, $p<0.05$); 10-19 days (OR=2.03, $p<0.01$); 20-29 days (OR=2.26, $p<0.01$) and used daily (OR=2.21, $p<0.01$) demonstrate statistical significance and positive odds relationships, hence, current users were more likely to use e-cigarettes compared to ever users.

Table 8 reports results from a multivariable logistic regression model predicting perceived use of e-cigarettes (See Table 8).

Table 8. Multivariable Logistic Regression Model Predicting Perceived Use of Electronic Cigarettes. (n = 19,861) (NCHA, Fall 2015)

PERCEIVED USE Variables	(1) Electronic Cigarettes -typical student (N = 16,378) Odds Ratio (OR)	95% Confidence Interval (CI)
Age Groups (in years)		
18-20	1.00	-
21-23	0.84	(0.650 - 1.084)
24-26	0.76*	(0.547 - 1.051)
27-29	0.71*	(0.491 - 1.041)
30 and above	0.71**	(0.531 - 0.962)
Gender		
Female	1.00	-
Male	1.11	(0.955 - 1.278)
Year in School		
1st year undergraduate	1.00	-
2nd year undergraduate	0.87	(0.700 - 1.082)
3rd year undergraduate	0.84	(0.660 - 1.059)
4th year undergraduate	0.70**	(0.512 - 0.957)
>4th year undergraduate	0.89	(0.596 - 1.341)
Graduate or professional	0.51***	(0.369 - 0.697)
Race Categories		
White	1.00	-
African-American	0.42***	(0.323 - 0.543)
Hispanic	0.94	(0.727 - 1.218)
Asian	0.73***	(0.581 - 0.929)
Current Residence		
Off-campus	1.00	-
On-campus	0.86*	(0.721 - 1.017)
Social Fraternity or Sorority Membership		
No	1.00	-
Yes	0.92	(0.745 - 1.145)
Other Substance Use Cigarettes-typical student		
Ever used	1.00	-
1-2 days	8.18***	(6.587 - 10.157)
3-5 days	13.04***	(10.165 - 16.741)
6-9 days	12.69***	(9.582 - 16.794)
10-19 days	17.57***	(12.821 - 24.090)
20-29 days	15.69***	(9.826 - 25.066)

Table 8 Continued

PERCEIVED USE	(1) Electronic Cigarettes -typical student (N = 16,378)	
Variables	Odds Ratio (OR)	95% Confidence Interval (CI)
Used daily	18.79***	(13.873 - 25.454)
Never used	0.13***	(0.102 - 0.157)
Alcohol-typical student		
Ever used	1.00	-
1-2 days	2.05***	(1.256 - 3.339)
3-5 days	2.73***	(1.686 - 4.432)
6-9 days	2.19***	(1.356 - 3.523)
10-19 days	2.42***	(1.494 - 3.934)
20-29 days	3.38***	(1.980 - 5.772)
Used daily	3.27***	(1.853 - 5.786)
Never used	0.58*	(0.308 - 1.081)
Marijuana-typical student		
Ever used	1.00	-
1-2 days	2.48***	(1.917 - 3.196)
3-5 days	3.18***	(2.433 - 4.147)
6-9 days	3.86***	(2.907 - 5.117)
10-19 days	4.02***	(2.982 - 5.415)
20-29 days	4.75***	(3.188 - 7.072)
Used daily	3.59***	(2.353 - 5.489)
Never used	0.39***	(0.287 - 0.522)
Constant	0.48***	(0.292 - 0.784)

*** p<0.01, ** p<0.05, * p<0.10

Multivariable logistic regression model (Table 8) predicting perceived e-cigarette use demonstrates, graduate or professional students (OR=0.51, p<0.01) show statistical significance but less likely to use e-cigarettes compared to first-year undergraduates. In terms of race, African Americans (OR=0.42, p<0.01) and Asian/Pacific Islander (OR=0.73, p<0.01) students exhibit statistical significance, however, less likely to use e-cigarettes than the Caucasians.

Similarly, as perceptions of typical student substance use increased, respondents were far more likely to contend the typical student used e-cigarettes. Among respondents who perceived the typical student to be a current cigarette smokers, 1-2 days (OR=8.18, p<0.01); 3-5 days (OR=13.04, p<0.01); 6-9 days (OR=12.69, p<0.01); 10-19 days (OR=17.57, p<0.01); 20-29 days

(OR=15.69, p<0.01) and used daily (OR=18.79, p<0.01) were at higher odds of using e-cigarettes compared to respondents who perceived the typical student was not a current smoker. Among respondents who perceived the typical student to be a current alcohol users, 1-2 days (OR=2.05, p<0.01); 3-5 days (OR=2.73, p<0.01); 6-9 days (OR=2.19, p<0.01); 10-19 days (OR=2.42, p<0.01); 20-29 days (OR=3.38, p<0.01) and used daily (OR=3.27, p<0.01) were at higher odds of using e-cigarettes compared to respondents who perceived the typical student was not a current alcohol user. Among respondents who perceived the typical student to be a current marijuana users, 1-2 days (OR=2.48, p<0.01); 3-5 days (OR=3.18, p<0.01); 6-9 days (OR=3.86, p<0.01); 10-19 days (OR=4.02, p<0.01); 20-29 days (OR=4.75, p<0.01) and used daily (OR=3.59, p<0.01) were at higher odds of using e-cigarettes compared to respondents who perceived the typical student was not a current marijuana user.

CHAPTER V

SUMMARY AND DISCUSSION

Key Research Findings and Policy Implications

We identified that approximately 5% of students were classified as current e-cigarette users. Also, male students (OR=2.28, $p<0.01$) were at higher odds of vaping compared to females. More than seven out of every ten respondents, however, thought the 'typical student' on their campus was an e-cigarette user. Exposure-response relationships among cigarettes, alcohol, and marijuana users were present, such that the likelihood of current vaping increased significantly as substance use increased. Similarly, as perceptions of typical student substance use increased, respondents were far more likely to contend the typical student used e-cigarettes.

After the founding of Juul Labs, Inc., in 2015, electronic cigarettes have rapidly emerged as a popular substance that increasingly affecting youth and young adults' health and behavior. Smoking e-cigarettes is a growing challenge between adolescent students and has already become a critical social concern for the last few years, particularly among parents and guardians. Our study objective primarily explores e-cigarette use among a national sample of U.S. college students. Additionally, across the nation, a state-by-state breakdown of e-cigarette regulations, smoking and vaping policies, and co-use of other substances was evaluated between college and university campuses. Specifically, we sought to analyze how the federal and state government, as well as the university management and administrations implementing smoking and vaping policies and smoke-free air legislation that serves college students' health status on their campus premises.

On December 10, 2019, the President of Texas A&M University in College Station, Michael K. Young, announced that the institution had adopted a system-wide, smoke-free and

tobacco-free campus policy which includes cigarettes, e-cigarettes, smokeless tobacco, and other nicotine delivery products. This memorandum is an excellent example of centralized policy management that applied across all campuses of the Texas A&M University System. However, smoke-free and tobacco-free laws are not always equal and well-defined across U.S. universities. For example, in Iowa, state-mandated laws are requiring 100% smoke-free campuses that applied to both public and private academic institutions. On the other hand, state laws of Louisiana demand 100% smoke-free campuses, which only appropriate to public colleges and universities. Several higher educational institutions with multiple campuses have authorized a centralized policy that covers smoking and vaping laws involving all campuses. However, some others made more flexible options that permit every single campus to manage its nicotine and tobacco policy independently. Additionally, in some cases, university administrations adopted smoke-free and tobacco-free policies within campus properties, but college students do not practically follow these laws due to a lack of appropriate monitoring and enforcement. Therefore, academic administrators should adopt effective and system-wide, vaping, and substance use policies. Besides, they should work to ensure e-cigarettes are included in the smoke-free and tobacco-free campus environment to prevent students' self-use behavior and, also, to mitigate social influences and peer pressure in the usage of e-cigarettes, on college campuses (American Nonsmokers' Rights Foundation, 2019).

Among college students, a critical concern would be the minimum age to purchase and acquire e-cigarettes, e-liquids, and vaping devices. For example, the minimum legal age of buying electronic cigarettes in Texas is 21 years. However, several other states have approved different minimum age laws for selling e-cigarettes and other tobacco products, typically at a minimum of 18 or 19 years (Public Health Law Center, 2019). However, in recent times, President Trump and his administration approved and signed new legislation in order to amend the Federal Food, Drug,

and Cosmetic Act (FFDCA) on December 20, 2019. According to the latest amendment, this law imposed more restrictions on selling tobacco products, particularly in retail stores. The purpose of the federal government was to make regulated tobacco products, currently available in the market, less accessible, and less attractive to the young population. Therefore, the new policy implemented age verification regulations for retailers and raised the federal minimum age of sale of any tobacco products from 18 to 21 years, which includes conventional cigarettes, cigars, and electronic cigarettes (U.S. Food and Drug Administration, 2020). Moreover, university administrations, state legislators, and law enforcement agencies should enact strict policies that decrease the number and proximity of vape shops, vape lounges, and small retailers that sell vaporizers, e-cigarettes, and other electronic nicotine delivery systems in the college neighborhood. Besides, the federal minimum age laws restricting youth access to e-cigarettes, there are some additional policy measures implemented by individual U.S. states, which may include a "ban" on flavored e-cigarettes, product packaging, taxation that is high enough, state licensing requirements for small businesses, and other retail restrictions (Public Health Law Center, 2019).

Limitations

This study consists of some limitations that need to be carefully addressed. Firstly, vaping behavior has emerged as a new trend within a short space of time among young adults and adolescents. There is not much empirical research that analyzes both actual personal use and perceived peer use of e-cigarettes, particularly involving college participants. Moreover, for the first time, electronic cigarette variables have added to the NCHA data in the semester of Fall 2015. Therefore, we identified a minimal number of e-cigarette related publications, including college students, after this year. Secondly, the National College Health Assessment survey is entirely

voluntary and allows individual respondents to skip over any answer to specific questions if they feel inconvenient about it. Thus, although the survey material is confidential, however, response rates are not fixed. As a result, there is a higher prospect of missing values in the survey data. Besides, according to the necessity of providing administrative guidance, institutions may choose options to self-select, design the research method, and can determine the at-risk target population. As a result, NCHA data interpretation may not be generalizable for students across all U.S. colleges and universities. Hence, this is a national survey; however, it would not be considered as 'nationally representative' (U.S. Department of Health and Human Services, 2019). Thirdly, a common issue with the addiction research and drug abuse surveys is that participants do not inevitably aspire to disclose that they are presently using or have used e-cigarettes, alcohol, marijuana, or other substances in the past, primarily due to privacy reasons. Thus, even though the survey is anonymous, significant answer responses from the sample could be unreliable or biased. Finally, the National College Health Assessment is a secondary data analysis survey, administered directly by its parent organization, the American College Health Association. Like other secondary data sources, researchers do not have any options to design the dataset, methodology, questionnaires, codebook, or to change/replace any variables according to their own research needs. For example, public health researchers may get benefits of using primary data analysis for more elaborative research to identify whether college students customized vaping devices within specific strengths and concentrations through mixing e-liquid brands, nicotine salts, THC-containing products, and flavorings. Secondary data analysis of survey responses does not provide such kind of flexibility and precision for designing a sophisticated study.

Future Research Direction

Given students perceived the typical student on their campus vaped, it would be important for future work to assess the relationship between vaping behaviors and perceptions. Respondents who used tobacco were at much higher odds of also using e-cigarettes. Universities should work to ensure e-cigarettes, vaporizers, and other electronic nicotine delivery systems are included in smoke-free and tobacco-free campus policies. We recommend university administrations seek to adopt effective and system-wide smoke-free and tobacco-free campus policies.

REFERENCES

Agarwal, D., Loukas, A., & Perry, C. L. (2018). Examining College Students' Social Environment, Normative Beliefs, and Attitudes in Subsequent Initiation of Electronic Nicotine Delivery Systems. *Health Education and Behavior*, *45*(4), 532–539. https://doi.org/10.1177/1090198117739672

American Academy of Pediatrics. (2015). Electronic nicotine delivery systems. *Pediatrics*. https://doi.org/10.1542/peds.2015-3222

American College Health Association. (2019). National College Health Assessment: Participation History. Retrieved December 12, 2019, from https://www.healthypeople.gov/2020/data-source/national-college-health-assessment

American College Health Association. (2019). NCHA Home. Retrieved December 12, 2019, from https://www.acha.org/NCHA/NCHA_Home

American Nonsmokers' Rights Foundation. (2019). Colleges - American Nonsmokers' Rights Foundation. no-smoke.org. Retrieved December 12, 2019, from https://no-smoke.org/at-risk-places/colleges/

American Nonsmokers' Rights Foundation. (2019). Smokefree and Tobacco-Free U . S . and Tribal Colleges and Universities, (510), 1–23.

Berg, C. J., Stratton, E., Schauer, G. L., Lewis, M., Wang, Y., Windle, M., & Kegler, M. (2015). Perceived harm, addictiveness, and social acceptability of tobacco products and marijuana among young adults: marijuana, hookah, and electronic cigarettes win. *Substance use & misuse*, *50*(1), 79-89.

Blake, K. D., Klein, A. L., Walpert, L., Casey, L., Hallett, C., Douglas, C., … Koh, H. K. (2019). Smoke-free and tobacco-free colleges and universities in the United States. *Tobacco*

Control, 1–6. https://doi.org/10.1136/tobaccocontrol-2018-054829

Bourdon, J. L., & Hancock, L. C. (2019). Using electronic audience response technology to track e-cigarette habits among college freshmen. *Addictive Behaviors*, *95*(February), 24–27. https://doi.org/10.1016/j.addbeh.2019.02.019

Brown, E. M., Henes, A. L., & Olson, L. T. (2016). E-Cigarette Policies on College Campuses: Student Use Behaviors, Awareness, and Policy Support. *Journal of Community Health*, *41*(6), 1110–1115. https://doi.org/10.1007/s10900-016-0262-y

Buu, A., Hu, Y. H., Wong, S. W., & Lin, H. C. (2019). Comparing American college and noncollege young adults on e-cigarette use patterns including polysubstance use and reasons for using e-cigarettes. *Journal of American College Health*, 1-7.

CASAA. (2019). Historical Timeline of Electronic Cigarettes. CASAA. Retrieved December 12, 2019, from http://www.casaa.org/historical-timeline-of-electronic-cigarettes/

Case, K. R., Hinds, J. T., Creamer, M. R., Loukas, A., & Perry, C. L. (2020). Who is JUULing and why? An examination of young adult electronic nicotine delivery systems users. *Journal of Adolescent Health*, *66*(1), 48-55.

Centers for Disease Control and Prevention. (2020). Outbreak of Lung Injury Associated with the Use of E-Cigarette, or Vaping, Products. Electronic Cigarettes. Smoking & Tobacco Use. CDC. Retrieved March 11, 2020, from https://www.cdc.gov/tobacco/basic_information/e-cigarettes/severe-lung-disease.html

Cheney, M. K., Harris, L. W., Gowin, M. J., & Huber, J. (2014). Smoking and membership in a fraternity or sorority: a systematic review of the literature. *Journal of American College Health*, *62*(4), 264-276.

Cheney, M. K., Gowin, M., & Clawson, A. H. (2018). Using the Ecological Model to understand

influences on college student vaping. *Journal of American College Health*, *66*(7), 597–607. https://doi.org/10.1080/07448481.2018.1440578

CNBC. (2018). Altria takes 35% stake in Juul, valu e-cigarette maker at $38 billion. Retrieved December 12, 2019, from https://www.cnbc.com/2018/12/20/altria-takes-stake-in-juul-a-pivotal-moment-for-the-e-cigarette-maker.html

Cobb, N. K., & Abrams, D. B. (2011). E-cigarette or drug-delivery device? Regulating novel nicotine products. *New England Journal of Medicine*. https://doi.org/10.1056/NEJMp1105249

Cooper, M., Loukas, A., Harrell, M. B., & Perry, C. L. (2017). College students' perceptions of risk and addictiveness of e-cigarettes and cigarettes. *Journal of American College Health*, *65*(2), 103-111.

Copeland, A. L., Peltier, M. R., & Waldo, K. (2017). Perceived risk and benefits of e-cigarette use among college students. *Addictive Behaviors*, *71*, 31-37.

Cullen, K. A., Ambrose, B. K., Gentzke, A. S., Apelberg, B. J., Jamal, A., & King, B. A. (2018). Notes from the field: use of electronic cigarettes and any tobacco product among middle and high school students—United States, 2011–2018. *Morbidity and Mortality Weekly Report*, *67*(45), 1276.

Cullen, K. A., Gentzke, A. S., Sawdey, M. D., Chang, J. T., Anic, G. M., Wang, T. W., ... & King, B. A. (2019). E-Cigarette use among youth in the United States, 2019. *Jama*, *322*(21), 2095-2103.

Dai, H. (2020). Self-reported marijuana use in electronic cigarettes among US youth, 2017 to 2018. *Jama*, *323*(5), 473-474.

Dai, H. (2020). Exposure to Secondhand Aerosol From Electronic Cigarettes Among US Youth

From 2015 to 2018. *JAMA pediatrics*, *174*(3), 298-300.

Dobbs, P. D., Hodges, E. J., Dunlap, C. M., & Cheney, M. K. (2020). Addiction vs. Dependence: A Mixed Methods Analysis of Young Adult JUUL Users. *Addictive Behaviors*, 106402.

Etter, J. F. (2018). Gateway effects and electronic cigarettes. *Addiction*, *113*(10), 1776–1783. https://doi.org/10.1111/add.13924

Food and Drug Administration. (2020). Vaporizers, E-Cigarettes, and other Electronic Nicotine Delivery Systems (ENDS). *Tobacco Products: Products, Guidance & Regulations: Products, Ingredienst & Components*. Retrieved from https://www.fda.gov/tobacco-products/products-ingredients-components/vaporizers-e-cigarettes-and-other-electronic-nicotine-delivery-systems-ends

Food and Drug Administration. (2020). Lung Injuries Associated with Use of Vaping Products. Retrieved from https://www.fda.gov/news-events/public-health-focus/lung-injuries-associated-use-vaping-products

Frohe, T., Leeman, R. F., Patock-Peckham, J., Ecker, A., Kraus, S., & Foster, D. W. (2018). Correlates of cannabis vape-pen use and knowledge among US college students. *Addictive behaviors reports*, *7*, 32-39.

Fehre, C. (2019). A brief history of the e-cigarette. OUPblog. Retrieved December 12, 2019, from https://blog.oup.com/2014/11/e-cigarette-vape-timeline/

Giroud, C., de Cesare, M., Berthet, A., Varlet, V., Concha-Lozano, N., & Favrat, B. (2015). E-cigarettes: A review of new trends in cannabis use. *International Journal of Environmental Research and Public Health*, *12*(8), 9988–10008. https://doi.org/10.3390/ijerph120809988

Hammond, D., Wackowski, O. A., Reid, J. L., & O'Connor, R. J. (2020). Use of JUUL e-cigarettes among youth in the United States. *Nicotine and Tobacco Research*, *22*(5), 827-

832.

Harrell, M. B., Weaver, S. R., Loukas, A., Creamer, M., Marti, C. N., Jackson, C. D., ... & Eriksen, M. P. (2017). Flavored e-cigarette use: Characterizing youth, young adult, and adult users. *Preventive medicine reports*, *5*, 33-40.

Harrell, P. T., Brandon, T. H., England, K. J., Barnett, T. E., Brockenberry, L. O., Simmons, V. N., & Quinn, G. P. (2019). Vaping Expectancies: A Qualitative Study among Young Adult Nonusers, Smokers, Vapers, and Dual Users. *Substance abuse: research and treatment*, *13*, 1178221819866210.

Hefner, K. R., Sollazzo, A., Mullaney, S., Coker, K. L., & Sofuoglu, M. (2019). E-cigarettes, alcohol use, and mental health: Use and perceptions of e-cigarettes among college students, by alcohol use and mental health status. *Addictive Behaviors*, *91*(February 2018), 12–20. https://doi.org/10.1016/j.addbeh.2018.10.040

Hiler, M., Spindle, T. R., Dick, D., Eissenberg, T., Breland, A., & Soule, E. (2020). Reasons for transition from electronic cigarette use to cigarette smoking among young adult college students. *Journal of Adolescent Health*, *66*(1), 56-63.

Hittner, J. B., Penmetsa, N., Bianculli, V., & Swickert, R. (2020). Personality and substance use correlates of e-cigarette use in college students. *Personality and Individual Differences*, *152*(September 2019), 109605. https://doi.org/10.1016/j.paid.2019.109605

Huang, J., Duan, Z., Kwok, J., Binns, S., Vera, L. E., Kim, Y., ... & Emery, S. L. (2019). Vaping versus JUULing: how the extraordinary growth and marketing of JUUL transformed the US retail e-cigarette market. *Tobacco control*, *28*(2), 146-151.

Ickes, M., Hester, J. W., Wiggins, A. T., Rayens, M. K., Hahn, E. J., & Kavuluru, R. (2019). Prevalence and reasons for Juul use among college students. *Journal of American College*

Health, *0*(0), 1–5. https://doi.org/10.1080/07448481.2019.1577867

Jones, C. B., Hill, M. L., Pardini, D. A., & Meier, M. H. (2016). Prevalence and correlates of vaping cannabis in a sample of young adults. *Psychology of Addictive Behaviors*, *30*(8), 915–921. https://doi.org/10.1037/adb0000217

Katz, S. J., Erkinnen, M., Lindgren, B., & Hatsukami, D. (2019). Beliefs about E-cigarettes: A Focus Group Study with college students. *American journal of health behavior*, *43*(1), 76-87.

Kenne, D. R., Mix, D., Banks, M., & Fischbein, R. (2016). Electronic cigarette initiation and correlates of use among never, former, and current tobacco cigarette smoking college students. *Journal of Substance Use*, *21*(5), 491-494.

Kenne, D. R., Fischbein, R. L., Tan, A. S. L., & Banks, M. (2017). The Use of Substances Other Than Nicotine in Electronic Cigarettes Among College Students. *Substance Abuse: Research and Treatment*, *11*. https://doi.org/10.1177/1178221817733736

King, B. A., Gammon, D. G., Marynak, K. L., & Rogers, T. (2018). Electronic cigarette sales in the United States, 2013-2017. *Jama*, *320*(13), 1379-1380.

King, B. A., Jones, C. M., Baldwin, G. T., & Briss, P. A. (2020). The EVALI and Youth Vaping Epidemics—Implications for Public Health. *New England Journal of Medicine*.

Leavens, E. L. S., Stevens, E. M., Brett, E. I., Leffingwell, T. R., & Wagener, T. L. (2019). JUUL in school: JUUL electronic cigarette use patterns, reasons for use, and social normative perceptions among college student ever users. *Addictive Behaviors*, *99*(September 2018). https://doi.org/10.1016/j.addbeh.2019.106047

Lee, H. Y., Lin, H. C., Seo, D. C., & Lohrmann, D. K. (2017). Determinants associated with E-cigarette adoption and use intention among college students. *Addictive Behaviors*, *65*, 102–

110. https://doi.org/10.1016/j.addbeh.2016.10.023

Littlefield, A. K., Gottlieb, J. C., Cohen, L. M., & Trotter, D. R. M. (2015). Electronic cigarette use among college students: Links to gender, race/ethnicity, smoking, and heavy drinking. *Journal of American College Health*, *63*(8), 523–529. https://doi.org/10.1080/07448481.2015.1043130

Loukas, A., Chow, S., Pasch, K. E., Li, X., Hinds, J. T., Marti, C. N., … Perry, C. L. (2016). College students' polytobacco use, cigarette cessation, and dependence. *American Journal of Health Behavior*, *40*(4), 514–522. https://doi.org/10.5993/AJHB.40.4.13

Luzius, A., Dobbs, P. D., & Jozkowksi, K. N. (2019). College students' reasons for using different e-cigarette products: A mixed methods analysis. *Journal of American College Health*, *0*(0), 1–7. https://doi.org/10.1080/07448481.2019.1618313

McCabe, S. E., Veliz, P., & Schulenberg, J. E. (2018). How collegiate fraternity and sorority involvement relates to substance use during young adulthood and substance use disorders in early midlife: A national longitudinal study. *Journal of Adolescent Health*, *62*(3), S35-S43.

Milicic, S., & Leatherdale, S. T. (2017). The associations between e-cigarettes and binge drinking, marijuana use, and energy drinks mixed with alcohol. *Journal of Adolescent Health*, *60*(3), 320-327.

Murthy, V. H. (2017). E-cigarette use among youth and young adults: a major public health concern. *JAMA pediatrics*, *171*(3), 209-210.

Noland, M., Ickes, M. J., Rayens, M. K., Butler, K., Wiggins, A. T., & Hahn, E. J. (2016). Social influences on use of cigarettes, e-cigarettes, and hookah by college students. *Journal of American College Health*, *64*(4), 319-328.

Omaiye, E. E., McWhirter, K. J., Luo, W., Pankow, J. F., & Talbot, P. (2019). High-Nicotine

Electronic Cigarette Products: Toxicity of JUUL Fluids and Aerosols Correlates Strongly with Nicotine and Some Flavor Chemical Concentrations. *Chemical Research in Toxicology, 32*(6), 1058–1069. research-article. https://doi.org/10.1021/acs.chemrestox.8b00381

Park, E., Livingston, J. A., Wang, W., Kwon, M., Eiden, R. D., & Chang, Y. P. (2020). Adolescent E-cigarette use trajectories and subsequent alcohol and marijuana use. *Addictive Behaviors, 103*, 106213.

Peltier, M. R., Waters, A. F., Roys, M. R., Stewart, S. A., Waldo, K. M., & Copeland, A. L. (2019). Dual users of e-cigarettes and cigarettes have greater positive smoking expectancies than regular smokers: a study of smoking expectancies among college students. *Journal of American College Health*, *0*(0), 1–6. https://doi.org/10.1080/07448481.2019.1590373

Public Health Law Center. (2019). U.S. E-Cigarette Regulations - 50 State Review. Retrieved from https://publichealthlawcenter.org/resources/us-e-cigarette-regulations-50-state-review

Roberts, M. E., Keller-Hamilton, B., Ferketich, A. K., & Berman, M. L. (2020). Juul and the upsurge of e-cigarette use among college undergraduates. *Journal of American College Health*, 1-4.

Roys, M. R., Peltier, M. R., Stewart, S. A., Waters, A. F., Waldo, K. M., & Copeland, A. L. (2020). The association between problematic alcohol use, risk perceptions, and e-cigarette use. *The American Journal of Drug and Alcohol Abuse*, *46*(2), 224-231.

Ruglass, L. M., Espinosa, A., Fitzpatrick, S., Meyer, M. K., Cadet, K., Sokolovsky, A., … White, H. R. (2019). Prevalence and Correlates of Concurrent and Simultaneous Cannabis and Cigarette Use among Past-Year Cannabis-Using US College Students. *Substance Use and Misuse*, *0*(0), 1–8. https://doi.org/10.1080/10826084.2019.1668015

Saddleson, M. L., Kozlowski, L. T., Giovino, G. A., Hawk, L. W., Murphy, J. M., MacLean, M. G., … Mahoney, M. C. (2015). Risky behaviors, e-cigarette use and susceptibility of use among college students. *Drug and Alcohol Dependence*, *149*, 25–30. https://doi.org/10.1016/j.drugalcdep.2015.01.001

Saddleson, M. L., Kozlowski, L. T., Giovino, G. A., Goniewicz, M. L., Mahoney, M. C., Homish, G. G., & Arora, A. (2016). Enjoyment and other reasons for electronic cigarette use: Results from college students in New York. *Addictive Behaviors*, *54*, 33–39. https://doi.org/10.1016/j.addbeh.2015.11.012

Schulenberg, J. E., Johnston, L. D., O'Malley, P. M., & Bachman, J. G., Miech, R. A. & Patrick, M. E. (2018). Monitoring the Future College Students & Adults Ages 19 – 60.

Sluzky, J. (2013). The history of the eCig: An infographic. Retrieved December 12, 2019, from https://www.paintthemoon.org/the-history-of-the-e-cig-an-infographic/

Soule, E. K., Rossheim, M. E., Cavazos, T. C., Bode, K., & Desrosiers, A. C. (2019). Cigarette, waterpipe, and electronic cigarette use among college fraternity and sorority members and athletes in the United States. *Journal of American College Health*, *0*(0), 1–7. https://doi.org/10.1080/07448481.2019.1680555

Spindle, T. R., Hiler, M. M., Cooke, M. E., Eissenberg, T., Kendler, K. S., & Dick, D. M. (2017). Electronic cigarette use and uptake of cigarette smoking: A longitudinal examination of U.S. college students. *Addictive Behaviors*, *67*(2017), 66–72. https://doi.org/10.1016/j.addbeh.2016.12.009

Sutfin, E. L., McCoy, T. P., Morrell, H. E., Hoeppner, B. B., & Wolfson, M. (2013). Electronic cigarette use by college students. *Drug and alcohol dependence*, *131*(3), 214-221.

Sutfin, E. L., Reboussin, B. A., Debinski, B., Wagoner, K. G., 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. https://doi.org/10.2105/AJPH.2015.302707

Temple, J. R., Shorey, R. C., Lu, Y., Torres, E., Stuart, G. L., & Le, V. D. (2017). E-cigarette use of young adults motivations and associations with combustible cigarette alcohol, marijuana, and other illicit drugs. *The American journal on addictions, 26*(4), 343-348.

Trivers, K. F., Phillips, E., Gentzke, A. S., Tynan, M. A., & Neff, L. J. (2018). Prevalence of cannabis use in electronic cigarettes among US youth. *JAMA pediatrics, 172*(11), 1097-1099.

Trumbo, C. W., & Harper, R. (2013). Use and perception of electronic cigarettes among college students. *Journal of American College Health, 61*(3), 149-155.

US Department of Health and Human Services. (2016). E-cigarette use among youth and young adults. A report of the Surgeon General. *Atlanta, GA*.

US Department of Health and Human Services. (2018). Surgeon General's advisory on e-cigarette use among youth. Washington, DC: US Department of Health and Human Services, Office of the Surgeon General. https://e-cigarettes.surgeongeneral.gov/documents/surgeon-generals-advisory-on-e-cigarette-use-among-youth-2018.pdf

Vallone, D. M., Bennett, M., Xiao, H., Pitzer, L., & Hair, E. C. (2019). Prevalence and correlates of JUUL use among a national sample of youth and young adults. *Tobacco control*, *28*(6), 603-609.

Vallone, D. M., Cuccia, A. F., Briggs, J., Xiao, H., Schillo, B. A., & Hair, E. C. (2020). Electronic cigarette and JUUL use among adolescents and young adults. *JAMA*

pediatrics, *174*(3), 277-286.

Veppo Vape Shop. (2019). Vapor Cigarettes Explained - Veppo Vape Shop. Retrieved December 12, 2019, from https://veppocig.com/vapor-cigarettes-explained/

Wallace, L. N., & Roche, M. J. (2018). Vaping in Context: Links Among E-cigarette Use, Social Status, and Peer Influence for College Students. *Journal of Drug Education*, *48*(1–2), 36–53. https://doi.org/10.1177/0047237918807706

Walley, S. C., Wilson, K. M., Winickoff, J. P., & Groner, J. (2019). A public health crisis: electronic cigarettes, vape, and JUUL. *Pediatrics*, *143*(6), e20182741.

Wang, T. W., Tynan, M. A., Hallett, C., Walpert, L., Hopkins, M., Konter, D., & King, B. A. (2017). Smoke-Free and Tobacco-Free Policies in Colleges and Universities —. *Morbidity and Mortality Weekly Report*, *67*(24). Retrieved from https://no-smoke.org/colleges-universities-list-criteria/.

White, A. (2018). Plans for the First E-cigarette Went Up in Smoke 50 Years Ago. *Smithsonian Magazine*. Retrieved from https://www.smithsonianmag.com/innovation/plans-for-first-e-cigarette-went-up-in-smoke-50-years-ago-180970730/

Willett, J. G., Bennett, M., Hair, E. C., Xiao, H., Greenberg, M. S., Harvey, E., ... & Vallone, D. (2019). Recognition, use and perceptions of JUUL among youth and young adults. *Tobacco control*, *28*(1), 115-116.

Wong, S. W., Lin, H. C., Piper, M. E., Siddiqui, A., & Buu, A. (2019). Measuring characteristics of e-cigarette consumption among college students. *Journal of American College Health*, *67*(4), 338–347. https://doi.org/10.1080/07448481.2018.1481075

APPENDIX A

HISTORY AND TIMELINE OF THE E-CIGARETTE

Table 9 gives historical context on the invention of the e-cigarette and provides a condensed timeline relative to its development and adoption globally across time (See Table 9).

Table 9. Historical Timeline of Electronic Cigarette Development and Evolution From a Global Perspective. (Oxford University Press blog, 2014; Consumer Advocates for Smoke-Free Alternatives Association, 2019; Vaporizer Reviews, 2019; Veppo Vape Shop, 2019; CNBC, 2018; Smithsonian Magazine, 2018; U.S. DHHS, 2016)

Year	Development
1963	American inventor, Herbert A. Gilbert, a resident from Pennsylvania, pioneered the world's first smokeless and non-tobacco cigarette and pronounced, "Smokeless." In that same year, he filed a U.S. patent for "a safe and harmless means for and method of smoking." However, Gilbert was not able to convince any manufacturers who could be willing to make and commercialize the product into the American market.
1979	Dr. Norman Jacobson pioneered the word "vaping" with others and developed the Favor cigarette.
2003	Chinese pharmacist and inventor, Hon Lik, registered a patent for the modern vapor electronic cigarette design.
2004	The first commercial e-cigarettes introduced from the Ruyan company in China.
2006	British Entrepreneur brothers, Umer and Tariq Sheikh, invented the cartomizer. Vaping was first introduced in Europe, and electronic cigarettes become available for sale in that continent.
2007	Electronic cigarettes entered the United States for commercial use. NJOY was one of the first major companies to sell e-cigarettes in the U.S. market, founded this year.
2013	E-cigarettes turned into a $1 billion industry.
2014	The word 'vape' was added to the Oxford English Dictionary and subsequently announced as the Word of the Year.
2015	Juul Labs, Inc. founded by Adam Bowen and James Monsees, two former smokers and graduate students at Stanford University in California. JUUL released their vaping pen, device, and pods.
2016	The U.S. Food and Drug Administration (FDA) issued the administrative rule and initiated exercising its regulatory authority over e-cigarettes as a tobacco product.
2018	Juul became the most popular e-cigarette brand among young people and represented about 75% of the U.S. market share. Tobacco giant, the Altria Group, purchased a 35% stake in Juul and invested $12.8 billion on the company.

APPENDIX B

QUANTITATIVE SUMMARY

Table 10 gives a quantitative summary of the frequency and percentage distribution about current, ever, and never users, and comparing, actual, and perceived use of electronic cigarettes (See Table 10).

Table 10. Frequency and Percentage Distribution Assessing Actual and Perceived Use of Electronic Cigarettes. (n = 19,861) (NCHA, Fall 2015)

Electronic Cigarettes	Actual Use N (%)	Perceived Use N (%)
Current used	956 (4.9)	14,393 (73.7)
Ever used	2,077 (10.6)	2,018 (10.3)
Never used	16,631 (84.6)	3,107 (15.9)
Total	19,664 (100.0)	19,518 (100.0)

APPENDIX C

REGRESSION ANALYSIS AND STATA ANNOTATED OUTPUT

```
. logistic e_cig2 i.agenew i.RNQ47A i.year_in_school i.race i.residence i.NQ59 i.cigarettes
i.alcohol i.marijuana

Logistic regression                             Number of obs     =     16,428
                                                LR chi2(36)       =    2331.05
                                                Prob > chi2       =     0.0000
Log likelihood = -2331.8107                     Pseudo R2         =     0.3333

------------------------------------------------------------------------------
             e_cig2 | Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------------+---------------------------------------------------------------
             agenew |
              21-23 |   .7592806   .1105422    -1.89   0.059     .5707915    1.010013
              24-26 |   .7202802   .1439966    -1.64   0.101     .4867786     1.06579
              27-29 |   .6600742   .1622367    -1.69   0.091     .4077367    1.068577
    30 and above    |   .7991192   .1408704    -1.27   0.203     .5656658     1.12892
                    |
             RNQ47A |
               Male |   2.277997   .1853918    10.12   0.000     1.942134    2.671942
                    |
      year_in_school |
2nd year undergraduate |   .6158794   .0730865    -4.08   0.000     .4880714    .7771555
3rd year undergraduate |   .4866632   .0633464    -5.53   0.000     .3770788    .6280943
4th year undergraduate |   .4311519    .075363    -4.81   0.000     .3060871    .6073174
5th year or more undergraduate |   .3308183   .0738132    -4.96   0.000     .2136323    .5122856
Graduate or professional |   .1524423   .0325027    -8.82   0.000     .1003733    .2315223
                    |
                race |
               BLACK |   .4884211   .0971175    -3.60   0.000     .3307819    .7211857
            HISPANIC |   .7108392    .104377    -2.32   0.020     .5330697    .9478916
               ASIAN |   .9220494   .1468298    -0.51   0.610     .6748487    1.259801
                    |
           residence |
```

On-campus	.9983728	.1016177	-0.02	0.987	.8178142	1.218796
NQ59						
Yes	.9943937	.1134886	-0.05	0.961	.7950822	1.243669
cigarettes						
1-2 days	2.082591	.2977096	5.13	0.000	1.573705	2.756034
3-5 days	3.01983	.5959234	5.60	0.000	2.051206	4.445861
6-9 days	2.463967	.5900671	3.77	0.000	1.540957	3.939847
10-19 days	3.341645	.7347053	5.49	0.000	2.171762	5.141719
20-29 days	4.012288	1.164923	4.79	0.000	2.271199	7.088085
Used daily	3.103191	.4871999	7.21	0.000	2.281236	4.221306
Never used	.1674246	.018877	-15.85	0.000	.1342291	.2088294
alcohol						
1-2 days	1.455311	.2302631	2.37	0.018	1.067275	1.984427
3-5 days	1.795784	.2845724	3.69	0.000	1.316336	2.449861
6-9 days	1.779387	.2859336	3.59	0.000	1.29864	2.438102
10-19 days	1.83938	.3024593	3.71	0.000	1.332612	2.538862
20-29 days	1.799234	.3762464	2.81	0.005	1.194233	2.710732
Used daily	1.737827	.5382243	1.78	0.074	.947065	3.188842
Never used	.5050939	.1024821	-3.37	0.001	.339364	.7517587
marijuana						
1-2 days	1.197129	.1733855	1.24	0.214	.9012753	1.590099
3-5 days	1.66497	.2852995	2.98	0.003	1.190007	2.329503
6-9 days	1.58531	.3300533	2.21	0.027	1.054141	2.38413
10-19 days	2.025179	.3844405	3.72	0.000	1.395981	2.93797
20-29 days	2.262719	.4839446	3.82	0.000	1.487914	3.44099
Used daily	2.210152	.4228656	4.15	0.000	1.519017	3.215744
Never used	.4803405	.0535129	-6.58	0.000	.3861181	.5975556
_cons	.213278	.0385288	-8.55	0.000	.1496842	.3038898

Note: _cons estimates baseline odds.

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. logistic e_cig2typ i.agenew i.RNQ47A i.year_in_school i.race i.residence i.NQ59 i.cigarettestyp
i.alcoholtyp i.marijuanatyp


Logistic regression                             Number of obs     =     16,378
                                                LR chi2(36)       =    9177.11
                                                Prob > chi2       =     0.0000
Log likelihood = -3020.0643                     Pseudo R2         =     0.6031

------------------------------------------------------------------------------------------------
                     e_cig2typ | Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------------------------+----------------------------------------------------------------
                       agenew |
                       21-23  |   .8395265   .1095145    -1.34   0.180     .6501251    1.084106
                       24-26  |   .7580214   .1263094    -1.66   0.096     .5468213    1.050794
                       27-29  |   .7148984   .1370412    -1.75   0.080     .4909924    1.040912
                 30 and above |   .7146233   .1084536    -2.21   0.027     .5307574    .9621845
                              |
                      RNQ47A |
                        Male  |   1.105094   .0821067     1.34   0.179      .955336    1.278327
                              |
                 year_in_school |
        2nd year undergraduate  |   .8701379   .0967974    -1.25   0.211     .6996764    1.082129
        3rd year undergraduate  |   .8361678   .1008888    -1.48   0.138     .6600711    1.059244
        4th year undergraduate  |   .6997689   .1118777    -2.23   0.026     .5115242     .957289
5th year or more undergraduate  |   .8942289   .1848985    -0.54   0.589     .5962754    1.341067
      Graduate or professional  |   .5069068   .0822143    -4.19   0.000     .3688699    .6965993
                              |
                         race |
                       BLACK  |   .4188171   .0553787    -6.58   0.000     .3232012    .5427199
                     HISPANIC  |   .9409761   .1237781    -0.46   0.644     .7271259     1.21772
                       ASIAN  |    .734423   .0879575    -2.58   0.010     .5807683    .9287304
                              |
                    residence |
                   On-campus  |   .8567495   .0751151    -1.76   0.078     .7214815    1.017378
                              |
```

NQ59						
Yes	.9233403	.1012862	-0.73	0.467	.7447129	1.144813
cigarettestyp						
1-2 days	8.179536	.9035671	19.03	0.000	6.587174	10.15683
3-5 days	13.04493	1.660164	20.18	0.000	10.16515	16.74056
6-9 days	12.68548	1.81579	17.75	0.000	9.582232	16.79374
10-19 days	17.5742	2.82762	17.82	0.000	12.82096	24.08965
20-29 days	15.69378	3.749382	11.52	0.000	9.825802	25.06612
Used daily	18.79149	2.909567	18.95	0.000	13.87287	25.45402
Never used	.1267725	.0138474	-18.91	0.000	.1023406	.1570371
alcoholtyp						
1-2 days	2.047452	.510813	2.87	0.004	1.255596	3.338702
3-5 days	2.733416	.6738776	4.08	0.000	1.685995	4.431545
6-9 days	2.185559	.5322704	3.21	0.001	1.356005	3.522605
10-19 days	2.424654	.598671	3.59	0.000	1.494444	3.933868
20-29 days	3.380402	.9228825	4.46	0.000	1.979621	5.772376
Used daily	3.274008	.9512147	4.08	0.000	1.852574	5.786071
Never used	.5771271	.1846649	-1.72	0.086	.3082551	1.08052
marijuanatyp						
1-2 days	2.475419	.3225611	6.96	0.000	1.917487	3.195693
3-5 days	3.176252	.4322451	8.49	0.000	2.43264	4.147171
6-9 days	3.856517	.5563569	9.36	0.000	2.906682	5.116737
10-19 days	4.018233	.6116949	9.14	0.000	2.981651	5.415186
20-29 days	4.748081	.9651994	7.66	0.000	3.187749	7.07216
Used daily	3.594096	.7764193	5.92	0.000	2.353465	5.488727
Never used	.3870417	.0589363	-6.23	0.000	.287172	.521643
_cons	.4785591	.1204709	-2.93	0.003	.2921843	.7838163

Note: _cons estimates baseline odds.