



Vaping among College Students during the COVID-19 Pandemic

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ABSTRACT

Coronavirus disease 2019 (COVID-19), caused by the severe acute respiratory syndrome coronavirus 2 (SARS-Cov-2), created a global pandemic that has changed many aspects of life. Because of respiratory implications, it is interesting to investigate the impact of the pandemic and its effects on the usage of tobacco products including vaping. The purpose of the study is to determine the prevalence of vaping among college students as well as their perceptions and knowledge of risks associated with tobacco use, primarily vaping. The investigators are interested in determining associations of vaping with demographics and use of alcohol and smoking, and "Intention to vape" products amid the pandemic. A cross-sectional survey of 353 students attending University of North Carolina in Wilmington was carried out. The study results showed about 43% and 67% reported ever using cigarettes and vaping products, respectively. Of the respondents, 25% reported current dual use (e-cigarettes and traditional cigarettes). About 55% of respondents maintained they would probably or definitely not use e-cigarettes either pre or post-COVID-19. There was, however, a slight decline (3.7%) in those reporting they would definitely use e-cigarettes post-COVID-19 vs. pre-COVID-19. The high prevalence of vaping (39.5%) during the pandemic among university students in our study warrants increased efforts to address this problem on a national level.

Keywords: Electronic cigarette, Vaping, Tobacco, COVID-19, Dual use.

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1. Introduction

The infamous coronavirus disease 2019 (COVID-19), caused by the severe acute respiratory syndrome coronavirus 2 (SARS-Cov-2), created a global pandemic that has lasted into 2022, more than 2 years. The pandemic has shaped many aspects of life including the economy ^[1], social interaction ^[2], and people's approach to health and safety ^[3]. The nature of SARS-Cov-2 is to attack the respiratory system, leading to symptoms such as dry cough, chest pain, and shortness of breath ^[3]. Because of these respiratory implications, it is interesting to investigate the impact of the pandemic and its effects on the usage of tobacco products (including electronic cigarettes, cigarettes, hookah, etc.). Prior research has identified a significant decrease in sleep quality, decrease in social support, and an increase in stress during a pandemic-related lockdown in some countries ^[4-6]. With this, an increase in the daily number of cigarettes was found ^[7]. Wang and colleagues ^[5] conducted a meta-analysis to determine prevalence of anxiety, depression, and stress in college students during the COVID-19 pandemic. The prevalence of anxiety, depression, and stress was 29% (95% CI, 19–25%), 37% (95% CI, 32–42%) among non-Chinese students vs 23% (95% CI, 8–39%) among Chinese students. The COVID-19 pandemic has had an overall negative psychological effect on college students. Other studies found an increase in stress levels and anxiety among college students in the United States during the pandemic ^[4,6].

Vaping has been considered an epidemic with major health concerns. Vaping has been on the rise, especially among teens and young adults in the United States ^[8,9]. Most e-cigarettes/vapes contain nicotine. Exposure to nicotine at an early age can harm the young brain (under the age of 25) and increases the risk of addiction to other drugs ^[9]. E-cigarettes are marketed as safer and more pleasant alternatives to combustible cigarettes ^[10]. Tobacco industry advertisements glamorize alternative tobacco products (e-

cigarettes and vapes) to attract adolescents and youth with emotional or sexual appeals ^[11]. Electronic cigarettes were regarded as highly socially acceptable among California college students ^[12]. Some studies found that e-cigarettes may be considered a gateway to cigarette initiation ^[13]. Other studies found that e-cigarettes contributed to a weakened immune system ^[14]. The research on understanding e-cigarettes and vaping products is still in its early stages, and scientists are still trying to understand the long-term health effects of e-cigarettes. Prior to COVID, the percentage of "current" and "ever" use of vape products among college students ranged between 17.7–40% ^[15-17]. Results from the 2018-2019 population survey showed that about 2.3 % of US adults reported current vaping ^[18]. The prevalence of vaping remains high during the pandemic ^[19]. Vaping was found to be highly prevalent (42.3%) among a group of 498 Appalachian college students who completed a health survey in 2018 ^[20]. This relatively flippant and accepting attitude of college students towards tobacco products was hypothesized to change during and after the COVID-19 pandemic and its related lockdowns. With the outbreak of COVID-19 and its impact on the respiratory system, vaping should be considered a harmful habit or activity that may place users at a bigger risk of more severe respiratory effects and other health problems ^[21]. Studies dated amid the pandemic show varying conclusions about how the pandemic influences tobacco usage. One study conducted in England showed only a medium association between COVID-19 and changes in the usage of electronic cigarettes. Moreover, few users attempted to quit because of COVID-19 concerns ^[22]. On the other hand, another study showed that e-cigarette use was reduced among youths and young adults during the pandemic with less access to vape products as a result of the stay-at-home directives during the pandemic ^[23]. However, recent studies show that vaping may increase susceptibility to COVID-19 and intensify the disease's severity. Two studies found that the use of electronic cigarettes can increase

the expression of an enzyme (ACE2) that allows the virus to enter into the host cell [24,25]. This new research could potentially deter people from using electronic cigarettes or at least challenge existing perceptions of the products.

The specific aims of this study are: 1) to measure the prevalence of vaping among a sample of students at the University of North Carolina in Wilmington (UNCW) during the COVID-19 pandemic; (2) to assess students' knowledge of risks associated with the tobacco use, primarily vaping; (3) to determine associations of vaping with demographics and use of alcohol and marijuana; and (4) to understand students' intentions to use vaping products because recent studies found that vaping may increase susceptibility to COVID-19 and may worsen an individual's symptoms.

2. Materials and Methods

Research Design and Data Collection Tool

A cross-sectional exploratory study design was used to describe and identify vaping habits, beliefs, and attitudes towards vaping. The population under study was all students enrolled in UNCW, one of the largest state universities in the southeast region of the country. The participants completed an anonymous survey that consisted of the following: demographics; tobacco, alcohol, and marijuana use; knowledge and harm level of vaping; and intention to vape products. The Center for Disease Control and Prevention (CDC) Behavioral Risk Factor Surveillance System (BRFSS), a population-level survey used to track smoking behavior in the United States, was used as a guide for creating the study questionnaire [26]. The questions on demographics, tobacco, alcohol, and marijuana use were adapted from the above-mentioned BRFSS. Several studies have examined the validity and reliability of measures on the BRFSS. Nelson and colleagues have reported validity and reliability evidence for the BRFSS current smoker item and for several demographic variables [27]. Even though the CDC does not report formal reliability and validity statistics for the BRFSS, these items have been widely used to

assess the prevalence of chronic diseases in the United States, have been modified over time by epidemiology experts at the CDC, and are generally considered a valid measure of health outcomes.

The first section of the survey consists of questions about different forms of tobacco use, such as electronic cigarettes, waterpipe, smokeless tobacco, as well as cigarettes including "ever use" and "current use." The CDC defines a current smoker as an adult who has smoked 100 cigarettes in his or her lifetime and who currently smokes tobacco [28]. This group of current users was divided into "everyday" smokers and "some days" smokers. The glossary that lists these terms does not specifically define "ever use." Following the wording applied by previous CDC's surveys, for the purpose of this study, "ever use" was defined as someone who has smoked at least one cigarette or ever taken one puff of an e-cigarette. The survey included questions on knowledge and attitudes about vaping or e-cigarettes. Dual users (users of both e-cigarettes and traditional cigarettes) were participants who used both conventional and electronic cigarettes. Additional questions were included about marijuana use and alcohol consumption, as prior research showed associations between tobacco and alcohol and marijuana use [29,30]. Due to recent studies that investigated associations between vaping and COVID-19, as well as the role of media in highlighting information about vaping and the pandemic, additional questions relating to knowledge, harm level, and intentions to use of vape products were also included in the survey. Those questions were adapted from prior published work [31,32].

Study Site and Participants

A university email was sent to a randomized selection of 3000 of UNCW's 18,000 students inviting them to participate in an anonymous survey. The inclusion criteria were being a UNCW student between the ages of 18 to 24 years old who could read and write English.

Study Recruitment

The study received support from the Office of Institutional Research and Planning (OIRP) with the study participants' recruitment. The OIRP provided a random sample of 3000 UNCW students between the ages of 18-24 years old. An invitation email to participate in the study was sent to 3000 students. The invitation email contained a link to the survey that was built into Qualtrics. Data collection occurred from April 2021 until October 2021. A total of 353 students responded by completing the questionnaire, with a response rate of 11.8%.

Data Analysis

SAS version 9.4 (SAS Institute, Cary, NC) was used for statistical analysis. Descriptive statistics were used to characterize the sample and to determine the prevalence of all the different forms of tobacco use and other behaviors among the sample. After examining cell sizes for reported behaviors using Likert style questions, responses of "Very Frequently," "Frequently," "Occasionally," and "Rarely" were collapsed to form a "Yes" binary response. The response "Never" was changed to a "No" response. The chi-square test (χ^2) or Fisher's exact test was used to determine associations between nominal socio-demographics and tobacco use and other behaviors. Because age was a continuous variable, we used a Pearson Product-Moment Correlation to determine associations with the derived, binary tobacco use and other behavior variables. A *p*-value of less than 0.05 was used to determine statistical significance in all analyses.

3. Results

Demographic Distribution of the Respondents 353 students responded to the survey (11.8% response rate). The respondents were predominantly white (89.1%) women (69.7%) with a mean age of 20.6 ± 1.7 years old. The largest proportion of participants who responded were seniors (34.6%) and those living off-campus with friends (46.3%). The majority of the participants were employed part time (53.18%).

Use of Tobacco Products, Alcohol, and Marijuana

Table 1 provides summary data on ever and current use of tobacco products. Approximately 43% and 67% reported ever using cigarettes and vaping products, respectively. Current use proportions were much lower with 8% reporting currently using cigarettes and 40% reporting currently using cigarettes or vaping. Twenty-five percent of participants reported currently using both cigarettes and e-cigarettes. With respect to frequency of alcohol and marijuana use, a large proportion of respondents reported at least occasional alcohol use (~73%), and approximately 33% reported at least occasional marijuana use (Table 2).

Associations between Demographics and Reported Tobacco, Alcohol, and Marijuana Use Associations between participant demographics and reporting any smoking, alcohol use, and marijuana use, can be seen in Table 3, where bolded cells signify significant general association. There were no significant correlations between age and any smoking and alcohol use. There were, however, several other significant associations to highlight. Women had the smallest proportion reporting any cigarette smoking at 4.9%, and the largest proportion reporting alcohol consumption in the last thirty days (91.8%). Full-time employment status was associated with highest rates of reported vaping (57.5%). Students living off campus, either with friends or alone, consistently reported vaping, alcohol use, and marijuana use in greater proportions in the last thirty days.

The authors also found associations between vaping and marijuana and alcohol consumption. The study results showed 97.1% of students who vape also reported alcohol use versus 84.5% who do not vape. In addition, the results showed 77.7% of students who vape reported marijuana use versus 31% who do not vape (Table 4).

Knowledge and Perceptions of Vaping and Intention of Use Pre- and Post-COVID-19

Perceptions of harm from cigarettes and vaping varied between the two products, with almost

100% identifying cigarette use as moderately or very harmful, and approximately 84% reporting the same perceived level of harm from vaping (Table 5). There was little variability between pre- and post-COVID-19 intentions to use e-cigarettes (Table 6). The majority (~55%) of

respondents maintained they would probably or definitely not use e-cigarettes either pre- or post-COVID-19. There was, however, a slight decline (3.7%) in those reporting they would definitely use e-cigarettes post-COVID-19 vs. pre-COVID-19.

Table 1. Ever use and current use of tobacco products ($N = 353$).

	Ever use		Current use	
	Frequency	Percent	Frequency	Percent
Cigarettes	153	43.3	27	7.7
Vaping	238	67.4	139	39.5
Use of cigarettes & e-cigarettes	Not Asked	Not Asked	88	25.0

Table 2. Alcohol and marijuana use ($N = 353$).

	Frequency	Percent
Alcohol		
Very Frequently	28	8.0
Frequently	78	22.2
Occasionally	149	42.5
Rarely	59	16.8
Never	37	10.5
Marijuana		
Very Frequently	43	12.3
Frequently	37	10.5
Occasionally	35	10.0
Rarely	58	16.5
Never	178	50.7

Table 3. Associations between demographics and reporting any smoking, alcohol, and marijuana use in the last 30 days.

Demographics	Smoking Cigarettes	Vaping	Cigarettes Vaping	&Alcohol Use	Marijuana Use
Age ¹	$r = -0.01$ $n (%)$	$r = -0.03$ $n (%)$	$r = 0.03$ $n (%)$	$r = 0.06$ $n (%)$	$r = -0.08$ $n (%)$
Gender					
Men	13 (13.5)	43 (44.8)	28 (29.2)	82 (85.4)	51 (53.1)
Women	12 (4.9)	93 (38.0)	57 (23.3)	225 (91.8)	118 (48.2)

Trans	1 (25.0)	1 (25.0)	1 (25.0)	3 (75.0)	2 (50.0)
Refused	1 (14.3)	2 (28.6)	2 (28.6)	5 (71.4)	3 (42.9)
Race					
White	25 (8.0)	125 (40.1)	81 (26.0)	279 (89.4)	158 (50.6)
Black	0 (0)	2 (28.6)	0 (0)	6 (85.7)	4 (57.1)
Other	2 (7.4)	12 (38.7)	7 (22.6)	29 (93.6)	12 (38.7)
Education					
High school or less	7 (9.2)	31 (40.8)	18 (23.7)	67 (88.2)	39 (51.3)
Some college	15 (6.3)	96 (40.5)	55 (23.2)	214 (90.3)	115 (48.5)
Bachelors	4 (11.4)	11 (31.4)	12 (34.3)	31 (88.6)	17 (48.6)
Employment					
Full time	4 (8.5)	27 (57.5)	12 (25.5)	41 (87.3)	26 (55.3)
Part time	9 (4.9)	68 (37.2)	46 (25.1)	169 (92.4)	96 (52.5)
Unemployed	10 (9.6)	35 (33.7)	25 (24.0)	90 (86.5)	43 (41.4)
Other	2 (18.1)	4 (36.4)	2 (18.2)	9 (81.8)	4 (36.4)
Year in School					
Freshman	5 (12.8)	16 (41.0)	12 (30.8)	35 (89.7)	19 (48.7)
Sophomore	4 (4.7)	34 (39.5)	17 (19.8)	77 (89.5)	43 (50.0)
Junior	8 (8.0)	46 (46.0)	27 (27.0)	94 (94.0)	51 (51.0)
Senior	9 (7.6)	40 (33.6)	30 (34.9)	101 (84.9)	55 (46.2)
Living					
On campus	4 (4.8)	26 (31.0)	17 (20.2)	73 (86.9)	32 (38.1)
Off campus alone	6 (12.8)	26 (55.3)	14 (29.8)	44 (93.6)	24 (51.1)
Off campus with friends	16 (9.9)	75 (46.6)	48 (29.8)	152 (94.4)	96 (59.6)
With parents	1 (1.8)	10 (17.9)	8 (14.3)	43 (76.8)	19 (33.9)

¹Pearson Product Correlation Coefficient between age and reporting any behavior vs. never. Bolded cells indicate a significant association at $p < 0.05$ using Fisher's Exact Test.

Table 4. Associations between current vaping and alcohol and marijuana use ($N = 352$).

	Vape		Do Not Vape		<i>p</i> -value
	Frequency	Percent	Frequency	Percent	
Alcohol					0.0002
Yes	135	97.1	180	84.5	
No	4	2.9	33	15.5	
Marijuana					<0.0001
Yes	108	77.7	66	31.0	
No	31	22.3	147	69.0	

Table 5. Harm perceptions and knowledge toward alternative tobacco products ($N = 353$).

	Frequency	Percentage
Level of harm from cigarettes		
Very harmful	318	90.3
Moderately harmful	32	9.1
Little bit harmful	1	0.3
Not at all	1	0.3
Level of harm from vaping		
Very harmful	156	44.2
Moderately harmful	139	39.6
Little bit harmful	55	15.7
Not at all	2	0.6

Table 6. Intention to use e-cigarettes pre- and post-COVID-19 ($N = 353$).

	Pre-COVID-19 <i>n</i> (%)	Post-COVID-19 <i>n</i> (%)
Definitely would not use	156 (44.3)	178 (50.6)
Probably would not use products	51 (14.5)	47 (13.4)
Might use product	33 (9.4)	30 (8.5)
Probably would use product	51 (13.9)	47 (13.4)
Definitely would use	63 (17.9)	50 (14.2)

4. Discussion

Our study measured the prevalence of vaping among a sample of UNCW students during the pandemic, assessed students' knowledge of risk, determined associations of vaping with demographics and alcohol and marijuana use, and worked to understand students' intentions regarding vaping products. Over the past decade, the use of electronic cigarettes has grown rapidly among young adults and youth in the United States [33-34]. There is limited research on how this trend continued into the pandemic. Among the few studies available, some indicate an increase in tobacco and other substance use, while others show a decrease in this trend [19,35-39]. The present study contributed to this limited group of literature by revealing a lack of significant change in college students' tobacco use

during the pandemic. Interestingly, the prevalence of vaping among these students was found to be much higher (39.5%) than those recently reported by the Monitoring the Future survey (6.1% in 2017 and 22% in 2019) [8]. This may be due to the characteristics of the sample and the region where these students came from (tobacco state, low tobacco taxes, lack of tobacco prevention programs, limited tobacco control and funding). The prevalence may also have been possibly fueled by the pandemic, participants' lack of awareness or willingness to use tobacco cessation programs, and less stringent campus tobacco policies (not a tobacco-free campus, smoking permitted 25 feet perimeter from each building). This data warrants deeper investigation and increased efforts to address this problem on a local and possibly state level.

The authors were interested to discover associations between demographics, tobacco use, and other behaviors such as alcohol and marijuana use. The study did find significant associations between vaping and alcohol and marijuana use ($p < 0.005$). This can be explained by the cluster of behaviors ^[40]. Prior research found associations of clustering of risk behaviors such as smoking, drinking, and cannabis use ^[40-42]. The current results add high significance to the limited evidence on the increased risk of alcohol and marijuana use among vapers ^[43]. These findings would be instrumental in providing a foundation for further exploratory studies. The present use of these results can help guide the direction of on-campus informational projects by the student healthcare center and explain outcomes for related cessation studies.

The study did not show any significant associations between age, smoking, and alcohol use. However, the study findings on higher prevalence of vaping among full-time students does highlight possible distress among students – those who had to overcome the physical and mental burden of working more (due to possible financial strain) may have coped through e-cigarette use. Lower family income among university students has been especially detrimental to students' psychological health during the pandemic ^[44]. This revelation suggests a need for an approach that is targeted towards employed students. For example, while the local university campus may have introduced workshops and social events that targeted mental resilience, the timing of these meetings was less flexible and may have conflicted with work schedules for fully employed students. While an average working university student might be employed part-time, the goal of university administration should be to accommodate all students, especially those who may experience higher financial vulnerability and, thus, may feel more pressured to drop out ^[45-47].

Additionally, the distinct gender difference – higher alcohol use among self-identified female students – puts a perspective on the silent

struggle among this group of students. A further investigation into this trend is required to determine whether this is a consistent problem that was prevalent in this group prior to the pandemic or whether this was amplified due to the perceived responsibilities and expectations during the pandemic. Targeted interventions would also be needed from the student health services to help this vulnerable population.

Further findings of higher substance (e-cigarette, alcohol, marijuana) use among university students, who live off-campus, confirms the persistence of the ongoing problem in this subpopulation ^[48]. More analysis is needed to determine the proximity and density of these substances' vendors within the college town as these factors are likely to contribute to the issue ^[49]. This deeper analysis is necessary in order to re-evaluate the current local policies on point-of-sale marketing and distribution of these products. In the case of tobacco control, national adaptation of the Tobacco 21 law has been instrumental in limiting tobacco product distribution; however, implementation of this legislation is still challenging on local and state levels, and, thus, requires further work ^[50]. Although point-of-sale marketing has been extensively studied across the nation, the current condition of this communication with consumers on local level is barely known, and, therefore, can benefit from investigation ^[51].

The knowledge and harm perception of vaping among the study sample was also another aim of the study. The study anticipated a significant decline in the use of vaping products due to the pandemic and the research that showed increased health risks and worse outcomes of COVID-19 among vape users. Although the reported change was not statistically significant in this sample, reduction in college students' intention to vape and increase in students' abstinence from e-cigarettes after March 2020 may be related to the COVID-19 pandemic, the information they are exposed to, and the channels through which they receive this information. In general, college students get their vaping information from social sources, media, advertising,

and the education they get in school ^[52]. In the United States, e-cigarette advertising is available on television, print, radio, and social media. Among these, compared to older generations, younger adults are more likely to be exposed to e-cigarette ads via digital marketing (e.g., social media like Snapchat, Instagram, YouTube, Facebook, emails, online ads) and television, as these are more heavily used in this generation ^[8,53-55]. Programming for digital marketing usually involves learning users' interests and adjusting the advertising and content based on their prior searches, likes, shares, lingering, purchases, and subscriptions ^[56]. Therefore, social media users who searched for these products out of curiosity or liked associated content in the past are likely to be exposed to more of this content. Because ever vaping is associated with exposure to e-cigarette ads ^[55], reinforcement from digital marketing can lead college students to vape and use the marketed products later on. Consequently, students who were on the fence about e-cigarette use ("probably/might use") before the pandemic may have remained in these categories after persuasion from online promotions.

During the pandemic, tobacco companies took advantage of the limited information on COVID-19 and heavily promoted e-cigarettes, offering incentives ^[57]. In some instances, these ads even included promises of protection against the virus ^[58]. Public health research counteracted these claims, revealing potential susceptibility of e-cigarette users to COVID-19 ^[59-61]. College students may have actively sought this information, signed up for these organizations' newsletters, read scientific journals, or engaged in these discussions with their professors, family, or health care providers, which may have led some of them to change their intentions related to tobacco use. While pre-pandemic research shows college students' health literacy is associated with demographic disparities rather than their major, healthcare work experience, or medical credentials ^[62], college students completing clinical hours during the pandemic in a medical

field may have a differing level of awareness. Further research can help clarify interactions between these factors.

Limitations

This study utilized a cross-sectional survey design which is prone to response bias, selection bias, and sample bias. Response bias may have been present as participants were enrolled in a health-related program class and may have felt uncomfortable providing information regarding e-cigarette use in such an environment. Selection bias is seen in the use of a convenience sample. Although the demographic characteristics of the sample population closely mirror those of the university population, sample bias may still be present due to the high proportion of females present in the sample population. Moreover, we had an age range of 18-24 years as inclusion criteria. That could have impacted the results. Because the study was conducted on a campus with less stringent tobacco policies and in a state where marijuana use is still not legal, it is possible that tobacco, alcohol, and marijuana use is lower among students in the sample population than might be seen at colleges that lack these stipulations.

5. Conclusions

Our study showed that the prevalence of vaping is on the rise among college students, and this parallels current research and trends in increased use of vape products among young adults in the United States. This signals the need for further research to investigate the use of vape products as well as proper education for youth regarding the health hazards of such products despite current media and advertising that glamorizes the use of vape products and minimizes the negative health effects. Even though there were no significant changes to "intention to use" pre- and post-pandemic among our sample, future studies that investigate associations between exposure to e-cigarette marketing and lower harm perceptions of e-cigarettes, intention to use e-cigarettes, and e-cigarette trial, are essential to highlight the need for advertising regulations that support public health goals ^[63].

Further studies that investigate any associations between COVID-19 and vape products are needed. To increase public's timely access to the evidence, it may be worth conducting more research to see if social media or other channels of information are more successful in raising awareness of the general population.

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