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Short communication

## Electronic cigarette use and perceptions during COVID-19

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### ABSTRACT

This study was designed to examine how the COVID-19 pandemic changed e-cigarette user habits and risk perceptions. A nationally distributed 52-item questionnaire assessed nicotine e-cigarette use, perceptions, COVID-19 diagnosis, demographic data, and vaping habits among respondents aged 16–96 years ( $n = 565$ ). Questions were developed in-house to assess vaping habits of users and risk perceptions of nicotine containing e-cigarette users and non-users both before and during the COVID-19 pandemic. Seventy-six percent of non-users believed that e-cigarette use would lead to worse COVID-19 symptoms, compared to 40% of e-cigarette users ( $P < 0.001$ ). Twenty-eight percent of non-users also believed that e-cigarette users were more likely to be infected with SARS-CoV-2, versus 11% of e-cigarette users ( $P < 0.001$ ). Fifty-eight percent of e-cigarette users described themselves as making no change in their e-cigarette usage, 10% decreased e-cigarette use, and 32% increased e-cigarette use during the pandemic. Twenty-five percent of users switched to vaping non-socially during the pandemic ( $P < 0.001$ ). Sixty-seven percent of e-cigarette users replied that they would decrease or stop vaping if diagnosed with COVID and 31% said they would continue ( $P < 0.001$ ). These findings reveal there are large differences in risk perception of e-cigarette use between users and non-users. Additionally, our findings characterize the habits of e-cigarette users during the COVID-19 pandemic, revealing users report steady to increased use, more caution in social settings, and would reduce usage if diagnosed with COVID-19.

### 1. Introduction

Widespread lockdowns and closures due to the coronavirus disease (COVID-19) pandemic have altered the social environment, potentially permanently. However, the implications of these changes on use of nicotine containing e-cigarettes remain unknown. E-cigarettes are used by over 1.5 million people in the United States (US) and have been found to result in adverse health outcomes [1]. One potential change associated with the pandemic relates to perceptions and usage of tobacco or e-cigarette products. Detailed behavioral data can help estimate the change in magnitude of e-cigarette use in a time of great social change [2]. While studies have focused on stressors related to addiction, this is the first to provide insight into both general population and tobacco consumer risk perceptions and behaviors during a pandemic [3].

### 2. Methods

Participants were recruited from June to September 2020 via advertisements placed on social media outlets including Craigslist, Facebook, Twitter, and Reddit, with paid advertisements on Instagram specifically targeting nicotine e-cigarette users. All participants underwent informed consent and were entered into weekly lotteries for a \$100 gift card. A 52-item SurveyMonkey questionnaire assessed e-cigarette

usage, perceptions, COVID-19 diagnosis, demographics, and vaping habits both before and during the pandemic.

Data were analyzed with SAS® OnDemand Studio 3.8 for Academics (Cary, NC). Of 670 submissions, 105 were excluded due to incomplete submission, invalid response, or decision to not participate. Descriptive statistics were stratified by e-cigarette usage. Mean and standard deviation were estimated for all continuous variables and indices. Chi square and t-tests were used to examine differences in proportions and means respectively. All study procedures were approved by the University of California San Diego Institutional Review Board (160204).

### 3. Results

A total of 565 completed survey responses were obtained, with 69% ( $n = 390$ ) reporting no e-cigarette use and 31% ( $n = 175$ ) reporting current e-cigarette use. Overall study participant demographics were comparable to the broader US population using 2019 US Census estimates (Table 1). Survey participants were evenly split across male and female genders (51% survey versus 51% US Census), white (57% versus 70%), not of Hispanic descent (88% versus 60%), with at least a high school education (96% versus 88%), and employed (64% versus 63%) [4]. Seventy-one percent of non-vaping survey participants and 56% of vaping participants were within the 16–29 age range. The 16–29 age

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**Table 1**  
Survey sample demographic data (n = 565) compared to 2019 U.S. census demographic data.

Demographic variable	Sample (% of survey population)	2019 U.S. Census (% of population)
Female	317 (51%)	51%
Male	212 (49%)	49%
White	310 (57%)	70%
Non-Hispanic	418 (22%)	40%
High School diploma or beyond	525 (96%)	88%
Employed	344 (64%)	63%
Age		
16-29	330 (67%)	26%
30-39	77 (15%)	16%
40-59	64 (13%)	35%
60+	24 (5%)	23%

range was selected due to the small number of teenage participants. Among non-vapers, 70% self-described as female with 35% among vapers. A majority of non-vaping and vaping subjects identified as white (54% and 64%, respectively). The demographic split between non-vaper and e-cigarette age strata is not a nationally representative sample due to the nature of the survey.

Risk perceptions of e-cigarette use were compared between non-vaping and vaping groups, with 30% of vapers noting no adverse health effects due to vaping e-cigarettes, compared to just 9% of non-users. Ninety percent of vapers thought that e-cigarettes were a safe alternative to conventional cigarettes, compared to 39% of non-users. Seventy-six percent of non-users believed that e-cigarette use would lead to worse COVID-19 symptoms, compared to 40% of users. Twenty-eight percent of non-users believed that e-cigarette users were more likely to be infected with SARS-CoV-2, versus only 11% of e-cigarette users (Fig. 1).

Among e-cigarette users, 58% described themselves as making no change in their e-cigarette usage, 10% decreasing e-cigarette use, and 32% increasing e-cigarette use during the pandemic with no significant difference between males and females (P = 0.525). Although 70% of e-cigarette users reported vaping in a social setting before the pandemic, 25% switched to vaping non-socially during the pandemic, which was

significant among the 16–29 age group but not among the older age groups (P < 0.001). Among the vaping respondents, six percent reported having had COVID-19 (non-users were not asked this particular question). Sixty-seven percent of e-cigarette users replied that they would decrease or stop vaping if diagnosed with COVID-19, while 31% would continue (P < 0.001) with no significant difference between males and females (P = 0.333).

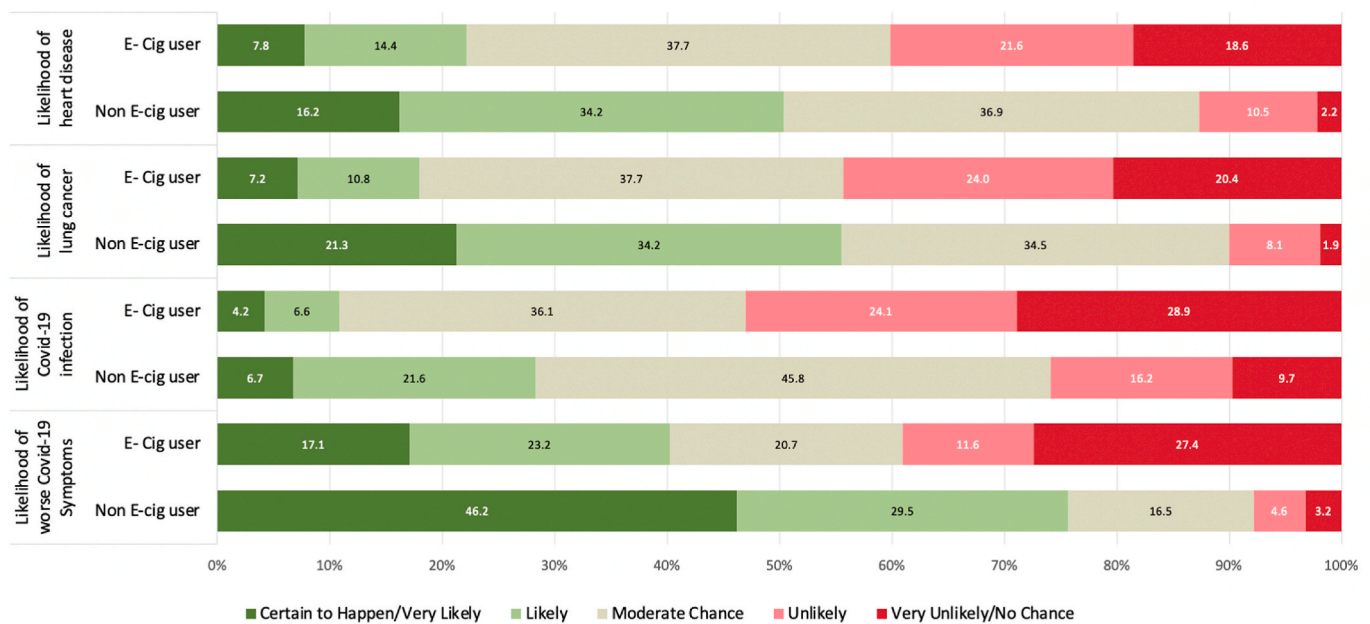
Participants were asked to highlight e-cigarette characteristics that were important before and during the pandemic. “Product characteristics” and “pharmacological effects” increased in importance, while other categories decreased in importance or remained the same (Fig. 2).

#### 4. Discussion

Our study provides insights into current habits and perceptions of e-cigarette users during the COVID-19 pandemic, including shifts in social usage of e-cigarettes, risk assessment, and direct usage habits. Focusing on e-cigarette usage before and during the pandemic allows us to examine e-cigarette users’ motivations in a time of great stress and social change.

Risk perceptions surrounding e-cigarette use and likelihood of COVID-19 and worse symptoms of COVID-19 were highly divergent among users and non-users. Findings aligned with risk perception data from other studies where users of e-cigarettes perceived e-cigarettes to be less harmful compared to perceptions of non-users [5].

Individuals who smoke and vape may be at higher risk for worse symptoms of COVID-19 [6]. Given the known health risks of lung injury and other health effects associated with COVID-19, it is concerning that users continue to vape despite known risks [7]. In our study, 90% of self-identified e-cigarette users had either increased use or did not change the amount they vape regardless of their gender. Individuals either may not be aware of the risks of vaping or are influenced by well-known promoters of e-cigarette use such as stress, addiction, and marketing [8]. Other findings include reduced use of e-cigarettes in a social setting among the youngest group aged 16–29, potentially the byproduct of pandemic response such as masks and social distancing, which “modified shared product use, flavors selected, and setting of use [9].” This finding is mirrored in participant responses noting increased importance in specific product preferences. Preferences specifically



**Fig. 1.** Risk perceptions associated with e-cigarette (e-cig) use among users and non-users.

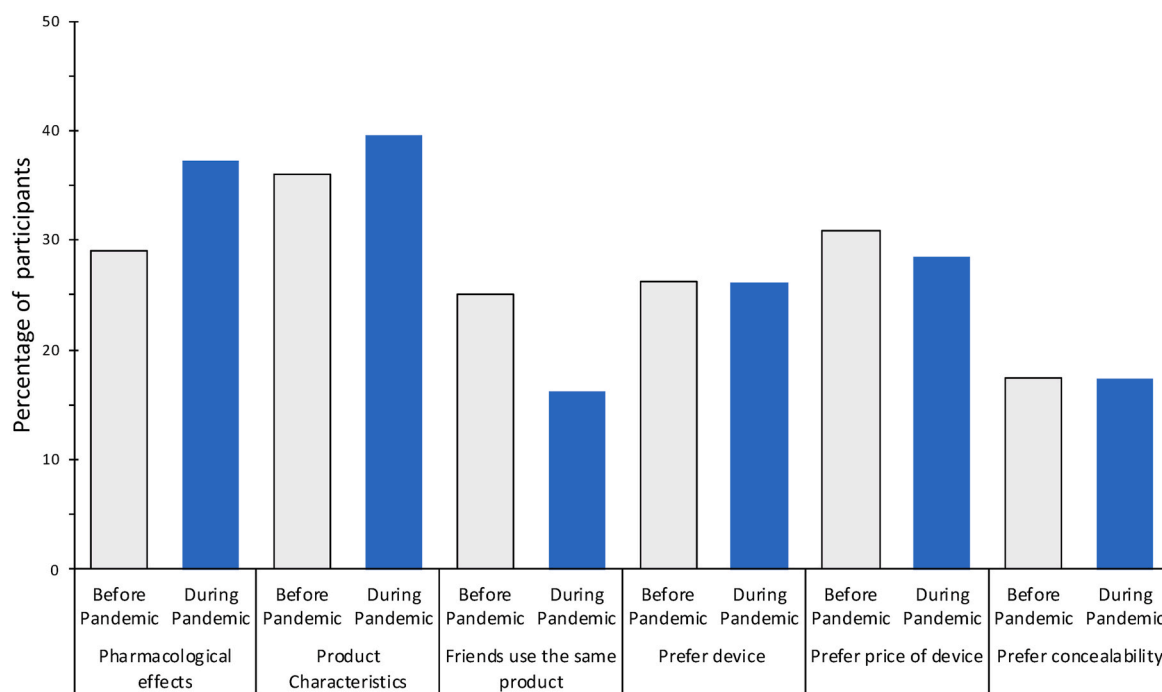


Fig. 2. Self-described importance of e-cigarette characteristics among vapers before and during the pandemic.

related to “shape, flavors available or size” of the e-cigarette as well as pharmacological effects described as ‘having a “buzz”’ over time, which may be a focus for future targets of regulation as well as treatments such as individual counseling for coping concerns.

A strength of the study has been the ability to obtain individual participants to evaluate changes in perceptions before and during the pandemic. In doing so, we document what e-cigarette users find most important when external pressures lead to changes in habits. Furthermore, our survey demographics are comparable to overall US census data and vaper demographics, implying broad generalizability of our findings [4,10]. Other studies have also shown that participants recruited through social media are not significantly different than those recruited via traditional means for smoking studies [11]. One limitation of our study was that participants were not asked whether they were dual users of e-cigarettes and conventional tobacco, or former users. Another limitation was the possibility of recall bias influencing reported pre-pandemic perceptions among users. Finally, the study’s cross-sectional design limits broader inference or assessment of temporality.

Studying e-cigarette users during the COVID-19 pandemic may provide a deeper understanding of user preferences and risk perceptions, which can be used as targets for changes in regulations to decrease e-cigarette use. Based on our results, understanding what specific product preferences and desired pharmacological effects users desire could potentially have the largest impact on successful regulations especially among the youngest users of e-cigarettes.

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#### Declaration of interest statement

All authors have read and approved of the manuscript for publication and declare no conflict of interest. The data presented in this manuscript are original and are not under consideration for publication elsewhere.

#### CRediT authorship contribution statement

**William Merz:** Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Writing – review & editing, Visualization. **Jose Magraner:** Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization. **Deepti Gunge:** Validation, Investigation, Writing – original draft, Writing – review & editing. **Ira Advani:** Validation, Investigation, Writing – original draft, Writing – review & editing. **Laura E. Crotty Alexander:** Methodology, Resources, Writing – review & editing, Funding acquisition. **Eyal Oren:** Conceptualization, Methodology, Resources, Writing – review & editing.

#### References

- [1] V.P. Krishnasamy, B.D. Hallowell, J.Y. Ko, A. Board, K.P. Hartnett, P.P. Salvatore, M. Danielson, A. Kite-Powell, E. Twentyman, L. Kim, A. Cyrus, M. Wallace, P. Melstrom, B. Haag, B.A. King, P. Briss, C.M. Jones, L.A. Pollack, S. Ellington, Update: characteristics of a nationwide outbreak of E-cigarette, or vaping, product use-associated lung injury - United States, august 2019-january 2020, *MMWR Morb. Mortal. Wkly. Rep.* 69 (2020) 90–94.
- [2] C. Vindrola-Padros, G. Chisnall, S. Cooper, A. Dowrick, N. Djellouli, S.M. Symmons, S. Martin, G. Singleton, S. Vanderslott, N. Vera, G.A. Johnson, Carrying out rapid qualitative research during a pandemic: emerging lessons from COVID-19, *Qual. Health Res.* 30 (2020) 2192–2204.
- [3] D. Kale, A. Herbec, O. Perski, S.E. Jackson, J. Brown, L. Shahab, Associations between vaping and Covid-19: cross-sectional findings from the HEBECO study, *Drug Alcohol Depend.* 221 (2021), 108590.
- [4] U.C. Bureau, Quick Facts, US Census Bureau, 2019. <https://www.census.gov/quick-facts/fact/table/US/PST045219>.
- [5] K. Romijnders, L. van Osch, H. de Vries, R. Talhout, Perceptions and reasons regarding E-cigarette use among users and non-users: a narrative literature review, *Int. J. Environ. Res. Publ. Health* 15 (6) (2018) 1190.
- [6] World Health Organization, Coronavirus Disease (COVID-19): Tobacco, World Health Organization, 2020. <https://www.who.int/westernpacific/news/q-a-detail/coronavirus-disease-covid-19-tobacco>.

- [7] Centers for Disease Control and Prevention, Long-Term Effects of COVID-19, Centers for Disease Control and Prevention, 2020. <https://www.cdc.gov/coronavirus/2019-ncov/long-term-effects.html>.
- [8] O.V. Torres, L.E. O'Dell, Stress is a principal factor that promotes tobacco use in females, *Prog. Neuro-Psychopharmacol. Biol. Psychiatry* 65 (2016) 260–268.
- [9] E.G. Klein, S. Koopman Gonzalez, S. Pike Moore, E.J. Bohnert, A.J. Quisenberry, E. S. Trapl, Pulling your mask down to smoke: qualitative themes from young adults on nicotine use during a pandemic, *Subst. Use Misuse* 56 (4) (2021) 437–441.
- [10] M. Mayer, C. Reyes-Guzman, R. Grana, K. Choi, N.D. Freedman, Demographic characteristics, cigarette smoking, and e-cigarette use among US adults, *JAMA Netw. Open* 3 (10) (2020), e2020694.
- [11] M. Frandsen, J. Walters, S.G. Ferguson, Exploring the viability of using online social media advertising as a recruitment method for smoking cessation clinical trials, *Nicotine Tob. Res.* 16 (2014) 247–251.