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Short communication

Preliminary impact of the COVID-19 pandemic on smoking and vaping in college students

Alexander W. Sokolovsky^{a,*}, Andrew W. Hertel^b, Lauren Micalizzi^a, Helene R. White^c,
 Kerri L. Hayes^a, Kristina M. Jackson^a

^a Center for Alcohol and Addiction Studies, Brown University, Box G-S121-5, Providence, RI 02912, United States

^b Department of Psychology, Knox College, 2 East South Street, Galesburg, IL 61401, United States

^c Rutgers Center of Alcohol and Substance Studies, 607 Allison Road, Piscataway, NJ 08854-8001, United States



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ABSTRACT

We examined tobacco use changes in young adult college students in the context of the COVID-19 pandemic, focusing on smoking and vaping. First, we evaluated changes in tobacco use from pre to post campus closure focusing on smoking and electronic nicotine vaping frequency (days) and quantity (cigarettes/cartridges per day). Also, given the potential protective effects of pausing (temporarily or permanently discontinuing) smoking or vaping, we evaluated its predictors. We hypothesized that generalized anxiety and moving home would increase the odds of pausing. We also explored effects of COVID-related news exposure and seeking on tobacco use. We re-contacted young adults two years after they completed a study on alcohol and marijuana co-use. A subset ($N = 83$; 26.6% of the 312 respondents) were enrolled in college and reported use of cigarettes ($n = 35$) and/or e-cigarettes ($n = 69$) in the week prior to their campus closing (PC). Paired sample t-tests compared smoking and vaping frequency and quantity PC to past-week use since closing (SC). Multivariate logistic regression models were fit to examine predictors of pausing. Both smoking and vaping frequency decreased from PC to SC; however, decreased frequency did not correspond to reduced quantity. Twenty-four participants (28.9%) paused past-week use SC. Higher anxiety and moving home (versus living independently) were related to increased odds of pausing, whereas COVID-19 related news exposure and seeking were related to decreased odds of pausing. Characterizing COVID-19 related tobacco use change provides insights into how college students respond to novel health threats and informs potential interventions.

1. Introduction

As highlighted by National Institute on Drug Abuse director Volkow (2020), people who use substances likely face numerous risks related to Coronavirus Disease 2019 (COVID-19), including increased risk of infection, poorer disease course, and increased mortality. These risks may be particularly pronounced for cigarette smokers and electronic nicotine delivery system (ENDS) vapers, as their toxicant exposure increases lung susceptibility and suppresses immune function (Gotts et al., 2019; Kaur et al., 2020). Indeed, animal models of lung immunity and theoretical work on nicotine-related modulation of cellular COVID-19 adhesion have illuminated several potential mechanisms by which tobacco use may alter COVID-19 disease course (Brake et al., 2020; Madison et al., 2019). Although direct evidence remains forthcoming, it appears that current smokers are prone to greater disease severity and

increased mortality than never smokers (Simons et al., 2020).

Given the considerable potential for adverse effects of tobacco use on COVID-19 outcomes and the concomitant protective potential of reduced use, understanding changes in tobacco use during COVID-19 is prudent. Such investigations remain limited. Klemperer et al. (2020) found that approximately one quarter of current US adult smokers queried online decreased smoking or vaping and one third increased motivation to quit due to COVID-19. Similar patterns were observed across several other countries (Yach, 2020), albeit with tempered observations on vaping frequency and an indication of increased vaping quantity. Critically, although these explorations provide essential descriptive information on changes in tobacco use in response to the COVID-19 pandemic, what predicts such changes is unknown.

The COVID-19 pandemic has the potential to impact multiple individual psychosocial factors particularly relevant to tobacco use,

* Corresponding author.

E-mail address: alexander_sokolovsky@brown.edu (A.W. Sokolovsky).

including daily behavioral patterns, living contexts, social contexts, mental health and stress, and perceived health risks. Changes in these domains may alter tobacco use; consequently, understanding not only broad changes in tobacco use during COVID-19, but specifically those changes related to disruptions in these domains could inform our understanding of how tobacco use changes in response to novel health threats. One particularly visible disruption during the COVID-19 pandemic has been the widespread closure of college campuses. Such closures entail changes in housing, learning, and access to social support and mental health resources for students. As campus closures are a discrete point in time within the COVID-19 pandemic corresponding with numerous sustained psychosocial and environmental changes for college students, they represent a natural within-subjects experiment of the impact of contextual changes on tobacco use.

We investigated COVID-19 pandemic-related predictors of tobacco use among college students. We focused on college students due to their frequent use of ENDS and the salience of this life period in the development of substance use (Arnett, 1998). We first explored changes in smoking and vaping frequency and quantity related to campus closure. Consistent with the limited extant research, we hypothesized decreases in smoking and vaping frequency and quantity following campus closure. We then investigated predictors of pausing (temporarily or permanently discontinuing) tobacco use in response to campus closure. Specifically, we investigated prediction by anxiety and housing, controlling for nicotine dependence. We anticipated that higher anxiety and moving to non-independent housing (e.g., with family or friend's family whose homes are likely to have stricter rules regarding tobacco use) (Clark et al., 2006) would be associated with pausing tobacco use. Additionally, given the mixed messaging surrounding tobacco and COVID-19 by the media and tobacco industry (Kamiński et al., 2020), we explored the effect of COVID-19 related news exposure and seeking on pausing. Research demonstrating unique relationships between active versus passive media exposure and tobacco product-related beliefs informed our decision to separately evaluate the role of news exposure (passive) versus seeking (active) (Donaldson et al., 2017).

2. Methods

2.1. Participants

We recontacted 473 participants who completed the last wave of a longitudinal study on alcohol and cannabis co-use in college students (Jackson et al., 2020). Criteria for being re-contacted comprised: 1) agreeing to be contacted for future studies and providing contact information, and 2) being a first- or second-year student during the baseline assessment of the parent study. Email contact information was valid for 439 individuals (92.8%) of which 312 (71.1%) completed data collection, exceeding the baseline response rate of the parent study (60.9%) (White et al., 2019). The analytic subsample included those participants currently enrolled in college ($N = 83$; 90.4% full-time, 9.6% part-time; abroad 1.1%) reporting tobacco use in the week prior to COVID-19-related campus closure (PC). This sample (52.4% female, 73.2% White, 8.5% Hispanic/Latino) included those who reported use of cigarettes ($n = 35$) and/or ENDS ($n = 69$). See Table 1 for descriptive statistics. Data collection occurred between May 25 and June 09, 2020. The Brown University Institutional Review Board approved all procedures.

2.2. Measures

Demographics included sex, age (continuous), race (American Indian, Asian, Black, Pacific Islander, White, Other, and Mixed Race recoded to White versus non-White), and ethnicity (Hispanic/Latinx versus non-Hispanic/Latinx).

Residence status change was assessed with two items, one PC ("Where did you live prior to campus closing"; responses: "dormitory/residence hall,"

Table 1

Sample descriptive statistics and cross-tabulation of tobacco use categories.

Variables	<i>M (SD) or n (%)</i>				
Age	21.2 (0.72)				
Female	43 (52.4%)				
Hispanic of Latino	7 (8.5%)				
Race (non-White)	22 (26.8%)				
GAD-7 Score	7.02 (5.73)				
HONC Scale Score	4.73 (3.46)				
COVID-19 News Exposure	4.02 (1.99)				
COVID-19 News Seeking	2.84 (1.76)				
Residence Status Change					
Moved to non-independent	42 (50.6%)				
Stayed non-independent	6 (7.2%)				
Stayed independent	35 (42.2%)				
	PC	SC ^c	<i>t</i>	<i>df</i>	<i>p</i>
Smoking Days ^a	2.83 (2.29)	1.34 (2.25)	4.17	34	<0.001
CPD ^a	1.10 (2.00)	1.03 (3.29)	0.26	33	0.800
Vaping Days ^a	4.84 (2.46)	3.81 (2.99)	3.48	68	0.001
eCPD ^{ab}	0.48 (0.49)	0.50 (0.86)	0.27	62	0.788
Tobacco Product Use Category					
<u>Product(s) PC</u>	Products SC:	None	Cigarette Only	ENDS Only	Dual Use
Cigarette Only		7	4	2	1
ENDS Only		15	0	29	4
Dual Use		2	1	11	7

Note: ^a Participants who reported using cigarettes or ENDS PC but not SC were coded as 0s in these variables SC. ^b eCPD is reported for the subset of vapers who reported using refillable cartridges or pod-mod devices. ^c SC values for cigarettes and ENDS summarize participants reporting use of those products PC. GAD = generalized anxiety disorder; HONC = Hooked on Nicotine Checklist; COVID-19 = Coronavirus Disease 2019; PC = prior to COVID-19 related campus closure; SC = since COVID-19 related campus closure; CPD = cigarettes per day; eCPD = e-cigarette cartridges per day; ENDS = electronic nicotine delivery systems.

"fraternity/sorority house," "apartment/house with parent(s)," "apartment/house with friend(s)/roommate(s)/partner," "apartment/house where I live alone," "other") and one since campus closure (SC; "Where do you currently live (since campus closed while taking classes)"; responses: "campus housing," "apartment/house with parent(s)," "apartment/house with friend's family," "apartment/house with friend(s)/roommate(s)/partner," "apartment/house where I live alone," "other: please specify"). We classified participants into three categories: 1) those living independently (i.e., not with family or friend's family) PC who continued to live independently SC; 2) those living independently PC who moved to a non-independent residence SC; and 3) those living non-independently PC who remained non-independent SC. No participants reported living non-independently PC and moving to an independent residence SC.

Tobacco frequency and quantity were assessed for both the PC and SC time periods.

Tobacco use frequency was assessed with single items ("In the [week before campus closed]past week], how many days did you [smoke cigarettes] use JUUL/e-cigarettes/nicotine vape") with response options from 0 to 7 days.

Tobacco use quantity was indexed as cigarettes per day (CPD) and e-liquid cartridges per day (eCPD). We assessed 7-day cigarette quantity with single items ("In the [week before campus closed]past week], on days you smoked, how many cigarettes did you usually smoke each day? A pack of cigarettes has 20 cigarettes"; responses: 1–40 and "40+" [recoded as 41];

observed range: 1–10 [PC], 1–18[SC]). Because most PC ENDS users reported using either pod-mods [84.1%] or refillable cartridges [10.1%], we assessed 7-day cartridge quantity with single items (“*In the [week before campus closed|past week], on the days you used e-cigarettes, how many cartridges did you use per day?*”; responses: “*less than ¼*” [recoded as 0.125], $\frac{1}{4}$, $\frac{1}{2}$, 1, 2, 3, 4, 5, and “*more than 5*” [recoded as 6]; observed range: 0.125–2 [PC], 0.125–6 [SC]). For both CPD and eCPD, quantity was multiplied by smoking or vaping days respectively and divided by seven.

Pausing tobacco use was computed by dichotomizing past-week tobacco use SC (0 days of both products = ‘*paused*’ [1]; 1–7 days of either product = ‘*not paused*’ [0]).

Nicotine dependence was assessed with the Hooked on Nicotine Checklist (HONC) (DiFranza et al., 2002). Participants who reported both smoking and vaping were queried regarding their primary tobacco product (“*Thinking about your use of cigarettes and JUUL/e-cigarettes/nicotine vapes, which is the primary product that you use, even if you haven’t been able to use since your campus closed?*”; responses: “*cigarettes,*” “*JUUL/e-cigarettes/nicotine vapes,*” or “*I use both equally*”). Exclusive smokers and those reporting cigarettes as their primary product received the HONC ($n = 16$; $\alpha = 0.92$); exclusive vapers and those reporting ENDS as their primary product received an adapted HONC for ENDS ($n = 64$; $\alpha = 0.90$) (Carroll et al., 2017; McKelvey et al., 2018); those reporting using both products equally ($n = 3$) were randomized to receive either version. Responses were summed to create HONC total scores (range: 1–10).

COVID-19 news exposure and seeking were assessed with two Likert-type items (“*I watch a lot of news about the coronavirus*” and “*I spend a huge percentage of my time trying to find updates online or on TV about coronavirus*”; responses: 1 (“*Not at all true for me*”)–7 (“*very true for me*”).

Severity of *generalized anxiety* symptoms was assessed with the Generalized Anxiety Disorder 7-item scale (GAD-7, $\alpha = 0.91$) (Spitzer et al., 2006).

2.3. Analysis plan

We first computed descriptive statistics and cross-tabulated tobacco use patterns between PC and SC. To investigate the impact of the COVID-19 pandemic on tobacco-use frequency and quantity, we conducted a series of within-subjects paired-sample *t*-tests comparing use from PC to SC. We separately evaluated changes in smoking versus vaping behaviors¹. To investigate the impact of the COVID-19 pandemic on pausing tobacco, we fit two logistic regression models. We regressed dichotomized tobacco pausing onto covariates (age, sex, race, ethnicity, nicotine dependence) and a-priori (generalized anxiety, residence status change) and exploratory (model 1: COVID-19 news exposure; model 2: COVID-19 news seeking) predictors. We exponentiated model coefficients to compute odds ratios (ORs) and profiled 95% confidence intervals (CIs). Due to the small sample size for these models and corresponding width of the anticipated CIs, significant findings were interpreted as preliminary indications of effect directionality as opposed to robust estimates of magnitude. Analyses were conducted using R 4.0.2 (R Core Team, 2017).

3. Results

3.1. Descriptive statistics

Sample descriptive statistics and cross-tabulations of tobacco product categories are presented in Table 1. PC, participants primarily

¹ We conducted paired-sample *t*-tests on these count outcomes as opposed to Wilcoxon signed-rank tests due to evidence from simulation studies suggesting lower bias for the *t* distribution and good performance for all but extremely small sample sizes (Proudfoot et al., 2018).

reported using ENDS only ($n = 48$, 57.8%), followed by dual use ($n = 21$; 25.3%) and cigarettes only ($n = 14$; 16.9%). Notably, 24 of 83 participants (28.9%) who reported tobacco use PC reported pausing past-week tobacco use SC.

3.2. Aim 1: Impact of COVID-19 on tobacco use frequency and quantity

3.2.1. Smoking quantity and frequency

Participants who reported smoking PC reported significantly fewer past-week smoking days SC ($t(34) = 4.17$, $p < .001$). There was not a significant difference in CPD between the PC and SC periods ($t(33) = 0.26$, $p = .800$).

3.2.2. Vaping quantity and frequency

Participants who reported using ENDS PC reported significant fewer past-week vaping days SC ($t(68) = 3.48$, $p = .001$). There was not a significant difference in eCPD between PC and SC ($t(62) = 0.27$, $p = .788$).

3.3. Aim 2: impact of COVID-19 on pausing tobacco

Results from multivariate logistic regressions predicting pausing past-week tobacco use are presented in Table 2; patterns were comparable across models. Higher generalized anxiety symptoms were associated with increased odds of pausing. Moving to non-independent residency (versus staying independent) was associated with increased odds of past-week pausing. Both COVID-19 news exposure and seeking were associated with reduced odds of past-week pausing. Higher HONC scores were associated with lower odds of past-week pausing. The only significant covariate was race.

4. Discussion

The present study is the first to systematically examine changes in college student smoking during the COVID-19 pandemic. Although collegiate smokers and vapers decreased tobacco use frequency in response to campus closure, quantity remained stable, suggesting that those with sustained tobacco use smoked and/or vaped more heavily on use days SC. With the potential for increased tobacco-related harm due to COVID-19 coupled with harm from tobacco use itself (Gotts et al., 2019; Kaur et al., 2020; Simons et al., 2020), research identifying and characterizing these individuals is necessary. For example, elucidating smoking motives during this pandemic may inform national messaging strategies to attenuate this potentially harmful behavior change.

Over one quarter of our sample paused past-week tobacco use SC. This rate is consistent with the proportions of adults reporting tobacco cessation in descriptive COVID-19 studies (Klemperer et al., 2020; Yach, 2020). Higher anxiety and moving to non-independent housing were associated with increased odds of pausing, beyond the influence of nicotine dependence. Much research has investigated the influence of context on substance use, and our findings further suggest that contextual changes (e.g., ‘coming home’ during summer breaks) could represent an untapped opportunity to facilitate cessation. Exploratory findings showed that COVID-19 news exposure and seeking were associated with lower odds of pausing tobacco. Observing that passive exposure and not merely active seeking contributed to reduced pausing highlights the important role of media in informing individual responses to novel health threats. It is possible that high levels of COVID-19 related news exposure and seeking increased psychological distress thereby motivating tobacco use from negative reinforcement (albeit our models did control for generalized anxiety). Alternatively, these findings may also relate to mixed media messaging regarding potential protective effects of nicotine against COVID-19 infection (Kamiński et al., 2020). Future research should clarify the content of and psychological reactions to active and passive media.

The generalizability of these findings is limited by the use of a small

Table 2

Effects of generalized anxiety, residence status change, and COVID-19 news exposure and seeking on tobacco cessation.

Predictors	Model 1				Model 2			
	OR	95% CI		p	OR	95% CI		p
		Low	High			Low	High	
Intercept	0.00	–	–	0.128	0.00	–	–	0.129
Age	2.54	0.89	9.03	0.102	2.27	0.85	6.87	0.113
Sex (ref: Female)	0.44	0.08	2.30	0.335	0.31	0.05	1.58	0.177
Ethnicity (ref: non-Hispanic/Latino)	2.98	0.11	98.9	0.529	2.73	0.08	140	0.602
Race (ref: White)	21.5	3.33	241	0.004	24.9	3.48	339	0.005
HONC Total Score	0.38	0.20	0.59	<0.001	0.40	0.22	0.61	<0.001
GAD-7 Total Score	1.31	1.09	1.67	0.011	1.25	1.06	1.53	0.014
Residence Status (ref: Stay independent)								
Move to non-independent	23.5	2.84	401	0.011	18.1	2.61	217	0.009
Stay non-independent	31.2	0.90	1812	0.066	28.9	0.64	1700	0.080
COVID-19 News Exposure	0.34	0.16	0.60	0.001	–	–	–	–
COVID-19 News Seeking	–	–	–	–	0.38	0.17	0.67	0.004

Note: OR = odds ratio; CI = confidence interval; HONC = Hooked on Nicotine Checklist; GAD = generalized anxiety disorder; COVID-19 = Coronavirus Disease 2019.

sample of college students. Additionally, data on tobacco use PC were assessed retrospectively. Nevertheless, our findings were generally consistent with prior exploratory work on tobacco use and COVID-19 (Klemperer et al., 2020; Yach, 2020) and supported our empirically-informed hypotheses. Further, our findings provide essential preliminary data informing larger epidemiological investigations of these effects.

5. Contributors

Alexander W. Sokolovsky was responsible for the conceptualization, formal analysis, and writing of the original draft as well as review and editing of the current manuscript. Andrew R. Hertel and Lauren Micalizzi were responsible for reviewing and editing the manuscript. Helene R. White and Kristina M. Jackson were responsible for funding acquisition, methodology, and reviewing and editing the manuscript. Kerri L. Hayes was responsible for data curation, project administration, and reviewing the manuscript.

CRedit authorship contribution statement

Alexander W. Sokolovsky: Investigation, Conceptualization, Methodology, Formal analysis, Writing - original draft. **Andrew W. Hertel:** Writing - review & editing. **Lauren Micalizzi:** Writing - review & editing. **Helene R. White:** Funding acquisition, Investigation, Writing - review & editing. **Kerri L. Hayes:** Data curation, Project administration. **Kristina M. Jackson:** Funding acquisition, Investigation, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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