



Exposure to e-cigarette content on social media and e-cigarette use: An ecological momentary assessment study

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ABSTRACT

This pilot ecological momentary assessment (EMA) study tested the associations between exposure to anti-e-cigarette content on social media and e-cigarette use behavior. For exposure to anti-e-cigarette posts, participants were asked to follow the study account on Instagram, on which anti-e-cigarette content were posted regularly. In addition, we assessed participants' exposure to pro-e-cigarette content in their daily lives and examined the effects of such exposure on behavior. Participants were 29 diverse young adult current e-cigarette users (18–30 year olds; 54% women), who provided data 3 times daily, for 3 weeks via a mobile phone based EMA application. Relative to no exposure, exposure to anti-e-cigarette content was associated with decreased recent e-cigarette use frequency at the next assessment time-point ($p < 0.05$; 2-tailed). In addition, a statistically significant concurrent association was found between exposure to pro-e-cigarette content (relative to no exposure) and higher e-cigarette use ($p < 0.05$; 2-tailed). The current data are some of the first to show that exposure to anti-e-cigarette content on social media may have real time effects on decreased e-cigarette use among young adults as they go about their daily lives. Policies and efforts designed to regulate pro-e-cigarette and promote anti-e-cigarette content on social media may help reduce e-cigarette use among young people.

1. Introduction

The marketing and promotion of e-cigarettes through traditional and non-traditional media (e.g., social media) may be one of the factors influencing high prevalence of e-cigarette use among young people (Hammond, Reid, Burkhalter, & Rynard, 2020). Over time, e-cigarette marketing has shifted from traditional media to social media platforms such as Facebook, Instagram, and Twitter (O'Brien, Hoffman, Navarro, & Ganz, 2020). Although a growing number of observational studies show that the exposure to social media e-cigarette content is associated with higher e-cigarette use among young people (Massey, Brockenberry, & Harrell, 2021; Pokhrel et al., 2021) the research approaches that have been employed in the area so far have been limited in important ways. With few exceptions (Pokhrel et al., 2021; Camenga et al., 2018), these associations have been based on cross-sectional studies; the few longitudinal studies that exist have relied on two or three waves of data collected at single time-points in gaps of several months, thus being subject to recall bias. In addition, studies have primarily considered

between-individual changes in e-cigarette use as a function of e-cigarette content exposure several months back. Importantly, almost all studies have focused solely on the effects of pro-e-cigarette content on e-cigarette use behavior and seldom examined the effects of anti-e-cigarette content.

To address these gaps, the current pilot study examined the effects of exposure to anti- and pro-e-cigarette content on social media on the e-cigarette use behavior of young adult current e-cigarette users, using ecological momentary assessments (EMA) (Bolger & Laurenceau, 2013). We sought to examine the momentary temporal associations between exposure to social media e-cigarette content and e-cigarette use behavior, within participants' natural environments. We hypothesized that exposure to anti-e-cigarette content would be associated with decreased e-cigarette use at the same assessment time-point (i.e., concurrently) and at the next same-day assessment time-point (i.e., prospectively), adjusting for demographic covariates, levels of craving for e-cigarettes, and individual differences in social media use behavior, sensation seeking, cigarette smoking status. In addition, we

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hypothesized that exposure to pro-e-cigarette content would be associated with increased e-cigarette use concurrently and prospectively, adjusting for the aforementioned covariates.

2. Method

2.1. Participants

Participants were 29 young adult current e-cigarette users, who ranged in age between 18 and 30 [M age = 24.3; SD = 3.3]. Fifty-four percent were women, 33% identified as White, 27% as Asian, 28% as Native Hawaiian or other Pacific Islander (NHOPI), and 12% as Other. Participants were self-reported daily e-cigarette users, of whom 56% reported having smoked combustible cigarette in the past 30 days.

2.2. Procedures

2.2.1. Recruitment

Young adult (18–30 years old) current e-cigarette users were recruited in Oahu, Hawaii, between January and March 2020, via advertisements on local media, mainly Craigslist, and through distribution of flyers at college campuses. To be included in the study, participants were required to: (1) be self-identified current e-cigarette users who reported using e-cigarettes for 20 or more days in the past 30 days; (2) be regular users of smartphone; (3) be willing to download the data collection application onto their phone; (4) be willing to appear in-person for the intake-and-orientation session; (5) have an Instagram account and used the account at least once a day; and (6) be willing to follow the current study's Instagram account. Interested individuals were screened by phone, and if eligible, invited to the study site for an in-person meeting.

2.2.2. Instagram and anti-e-cigarette ads

During the in-person study orientation, participants were asked to follow the study's Instagram account. Two anti-e-cigarette digital display ads that were originally developed for a national social media campaign with adolescents and young adults as target populations were obtained from the Centers for Disease Control & Prevention's (CDC) Media Campaign Resource Center (MCRC) (CDC, 2020) and utilized. Each ad was alternately posted every day by research staff on Instagram via feed posts. Instead of forcing the ads on participants, we wanted participants to come across the ads during their normal browsing of Instagram. We wanted to mimic real world exposure as much as possible. Put another way, by releasing the ads on Instagram, we were seeking to increase the chances of participants' exposure to anti-e-cigarette ads. Thus, we had no mechanism in place to ensure whether or not they were exposed to the ads.

2.2.3. Data collection

During the in-person meeting, research staff obtained consent and participants completed a baseline assessment survey. Staff assisted the participants to download and set up the Metricwire application, which was used to collect and manage EMA data, onto his/her phone. Prior to leaving, participants completed a sample EMA to familiarize themselves with the process. Staff explained each of the EMA questions in detail to the participants. Signal-contingent EMA procedures began the next day. Participants received three random prompts through the Metricwire app each day for 21 consecutive days between 8 am–12 pm, 12 pm–6 pm, and 6 pm–10 pm. After being prompted, participants completed the EMA items in the app and were allowed one hour to respond, with reminders at 20 and 50 min after the initial prompt. Each subsequent prompt was separated in time by at least two hours from the last prompt. To minimize response bias, we did not include an option for self-initiated event-based assessments. Each participant was provided with a \$25 supermarket gift-card for completing the baseline survey and EMA training, and an additional \$25 gift card at the conclusion of his/her 21-

day participation.

2.3. Measures

2.3.1. Baseline survey

Demographics were assessed with single-items for participants' age, gender, and ethnicity. Number of hours worked for pay per week was assessed as a proxy for socioeconomic status (SES). *Sensation seeking* was assessed with the 8-item Brief Sensation Seeking Scale (BSSS) (Crobach's $\alpha = 0.85$; current study) (Hoyle, Stephenson, Palmgreen, Lorch, & Donohew, 2002). *Social media use* frequency was measured on a 4-point scale (i.e., "Never," "Rarely," "Sometimes," "Often") for a list of social media platforms popular among U.S. young adults (e.g., Facebook, Instagram, Twitter, YouTube, and Snapchat) (Pokhrel et al., 2021). *Cigarette smoking* was assessed in terms of past-30-day smoking: "During the last 30 days (1 month), on how many days did you smoke a cigarette?" (8-point scale: "0 days," "1–2 days," "3–5 days," ..., "All days"). Participants who reported any cigarette smoking in the past 30 days were considered dual users of cigarette and e-cigarette.

2.3.2. EMA questions

For recent *social media use*, participants were asked, "Which of the following social media have you accessed since the last prompt (Select ALL that apply)?" Response options included "Facebook," "Instagram," "Twitter," "Snapchat," and "Reddit." For *exposure to e-cigarette content on social media use*, participants were asked, "Did you notice any posts/ads about e-cigarettes on social media since the previous message?" Participants who responded "Yes" to this question were further asked: "The posts/ads you saw about e-cigarettes were (select one): 'Pro-e-cigarette,' 'Anti-e-cigarette,' or 'Both.'" *Craving for e-cigarette* was assessed with a single question: "How much are you craving an e-cigarette (vape) right now?" Response options included: "1: Not at all; 2: A little; 3: Somewhat; 4: A lot; and 5: Extremely." *Cigarette smoking* was assessed with a single question: "How many cigarettes have you smoked since the last prompt? Provide a number. (If none, type 0)." *E-cigarette use* was assessed with the following question: "How many times have you vaped (used an e-cigarette) since the last prompt? Provide a number. (If none, type 0)." For this question, during orientation, participants were trained that number of times referred to number of vaping sessions, not number of puffs.

2.4. Data analysis

The associations between prior and concurrent exposures to social media e-cigarette content and e-cigarette use were tested using multi-level regression models in SAS. Multilevel models such as PROC MIXED in SAS are able to model variability in outcomes within (Level 1) and between individuals (Level 2) in terms of fixed and random effects. The first model tested the association between concurrently assessed exposure to social media e-cigarette content (pro-e-cigarette, anti-e-cigarette, and both-type exposure dummy coded with reference to none) (i.e., exposure since last prompt) as the main independent variable and e-cigarette use (i.e., number of times vaped since last prompt) as the dependent variable. A Level 1 covariate adjusted for in the model included momentary craving for e-cigarette. The following Level 2 covariates were included in the model: age, ethnicity (Asian, NHOPI, and Other, dummy-coded with reference to White), sex, number of hours worked for pay per week, sensation seeking, social media use frequency, and dual use status. The second time-lagged model tested the effects of exposure to social media e-cigarette content at one time-point in a day on the e-cigarette use behavior reported at the subsequent time-point. The same covariates as in the previous model were included. For both models, e-cigarette craving, being a Level 1 covariate, was centered on the within-person mean, and all continuous Level 2 covariates were centered on the grand mean.

3. Results

Of the total 1827 prompts sent to participants over 21 days, we received 1260 responses (response rate = 69%). The average total frequency of e-cigarette use sessions over 21 days was 331 (SD = 468), whereas the average cigarette smoking frequency was 47 (SD = 66). Across prompts, on average, participants reported recent Instagram use most often (M = 27), followed by Facebook (M = 17), Snapchat (M = 13), and Twitter (M = 7). Participants reported being exposed to pro-e-cigarette and anti-e-cigarette content on social media, on average, approximately 1 and 3 times, over 21 days, respectively.

Table 1 shows the results of the analysis examining the associations between social media e-cigarette content exposure and e-cigarette use, assessed concurrently. We found that exposure to pro-e-cigarette content was statistically significantly associated with more frequent e-cigarette use. Anti-e-cigarette content exposure was not associated with concurrent e-cigarette use. Among Level 2 variables, only younger age was significantly associated with greater e-cigarette use.

Table 2 shows the results of the analysis testing the effects of exposure to social media e-cigarette content on e-cigarette use at the next assessment time-point within a day, using a time-lagged model. Exposure to anti-e-cigarette content was found to have a statistically significant effect on decreased e-cigarette use later in the day. Exposure to pro-e-cigarette content was not found to have significant effect on later e-cigarette use. E-cigarette craving was not found to affect later e-cigarette use. Among Level 2 predictors, only younger age was significantly associated with greater e-cigarette use frequency.

4. Discussion

The current study is one of the first to provide a preliminary test of the momentary effects of exposure to anti- and pro-e-cigarette social media content on e-cigarette use among young adults in their daily lives. The study was mainly designed to test the effects of exposure to anti-e-cigarette ads on social media. In order to increase the participants' chances of being exposed to anti-e-cigarette ads, we had them follow the study Instagram account. It is known that pro-e-cigarette content is more prevalent on social media (McCausland, Maycock, Leaver, & Jancey, 2019). In the current data, however, participants were more likely to be exposed to anti-e-cigarette ads. This may suggest that participants' following of the study's Instagram's account increased the participants' chances of being exposed to anti-e-cigarette ads. Although this cannot be empirically proven based on the current data, the finding raises the possibility that using Instagram to expose young adults to anti-e-cigarette ads may work.

Table 1

Concurrent association of exposure to social media e-cigarette content and e-cigarette, adjusting for level 1 and level 2 covariates.

Level 1 Predictors		Fixed effects <i>b</i> (SE)
Social media exposure to (ref: no exposure)		
	Anti-E-Cig content	0.15 (0.09)
	Pro-E-Cig content	0.36 (0.16)*
	Both	-0.15 (0.20)
Craving for e-cigarette		0.08 (0.06)
Level 2 Predictors		
Ethnicity (ref: White)	Asian	-0.19 (0.42)
	NHOPI	0.25 (0.41)
	Other	0.27 (0.60)
Age		-0.12 (0.06)*
Gender: Female		-0.16 (0.36)
Hours worked for pay		0.01 (0.09)
Sensation seeking		-0.05 (0.25)
Social media use behavior		-0.02 (0.06)
Dual use status		-0.54 (0.36)

Note. *p < 0.05 (2-tailed); ref: Reference group.

Table 2

Exposure to social media e-cigarette content as a predictor of e-cigarette use at the subsequent assessment time-point, adjusting for level 1 and level 2 covariates.

Level 1 Predictors		Fixed effects <i>b</i> (SE)
Social media exposure (ref: no exposure)		
	Anti-E-Cig content	-0.28 (0.13)*
	Pro-E-Cig content	0.03 (0.22)
	Both	0.02 (0.22)
Craving for e-cigarette		0.04 (0.07)
Level 2 Predictors		
Ethnicity (ref: White)	Asian	-0.28 (0.44)
	NHOPI	0.26 (0.43)
	Other	0.05 (0.63)
Age		-0.11 (0.06)*
Gender: Female		-0.21 (0.36)
Hours worked for pay		-0.01 (0.09)
Sensation seeking		-0.04 (0.26)
Social media use behavior		-0.01 (0.06)
Dual use status		0.57 (0.37)

Note. *p < 0.05 (2-tailed); ref: Reference group.

Our hypotheses were partially supported. Exposure to anti-e-cigarette content had an inverse effect on e-cigarette use during the next assessment timeframe, but was not associated with e-cigarette use during the same assessment timeframe. On the other hand, exposure to pro-e-cigarette content was associated with increased e-cigarette use within the same assessment timeframe, but was not associated with e-cigarette use during the subsequent assessment timeframe. Based on these findings, it appears that the effects of exposure to pro-e-cigarette content may be more immediate, perhaps even cued, whereas the effects of exposure to anti-e-cigarette may take relatively longer to impact behavior. These findings, however, need to be replicated in a bigger sample to fully understand the moment-to-moment associations between social media e-cigarette content exposure and e-cigarette use outcomes. Future studies may especially need to pay attention to the effects of exposure to anti-e-cigarette content, as this topic has been generally overlooked in research. Furthermore, future, larger studies will need to examine how demographic and social media use characteristics interact with social media e-cigarette content exposure to influence e-cigarette use behavior. Experimental designs that manipulate pro-vaping, anti-vaping, or neutral content would provide evidence for the causal relation between advertising and e-cigarette use. Owing to its preliminary nature, this study has a number of limitations. First, although comparable to other EMA studies with young adults (Berg et al., 2019; Cooper et al., 2019), a higher response rate would have been desirable. Second, the current study was powered only to test the main-effects hypotheses of interest. Given the small sample, we were unable to test various interaction effects. A larger sample size may have detected smaller, statistically significant between-subject effects. Third, the current study was based on regular Instagram users and may not generalize to other social media platforms. Despite limitations, this study provides some initial evidence that exposure to social media content may have real-time effects on e-cigarette use behavior in real-world settings.

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6. Contributors

PP designed the study. PP and IP conducted the data analysis. KTP and PP drafted the manuscript, with assistance from RT and KJT. CTK, RT, and AYM made conceptual inputs into the designing of the study and assisted with manuscript preparation. CTK, RT, and KJT managed data

collection and management.

CRedit authorship contribution statement

Pallav Pokhrel: Conceptualization, Methodology, Formal analysis, Writing - original draft, Funding acquisition, Supervision. **Kristina T. Phillips:** Writing - original draft. **Crissy T. Kawamoto:** Conceptualization, Data curation, Writing - review & editing. **Rachel Taketa:** Conceptualization, Data curation, Writing - review & editing. **Kayzel J. Tabangcura:** Data curation, Writing - review & editing. **Amanda Yoshioka-Maxwell:** Data curation, Writing - review & editing. **Ian Pagano:** Formal analysis.

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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