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Smoking-Related Weight and Appetite Concerns and Use of Electronic Cigarettes Among Daily Cigarette Smokers

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Abstract

Weight control is a common motive for cigarette smoking because nicotine suppresses appetite and smoking is a behavioral alternative to eating. Electronic cigarettes (e-cigarettes) are also used for weight control in some individuals. The current study tested the hypothesis that the tendency to use combustible cigarettes for weight/appetite control would be associated with higher odds of current e-cigarette use among daily combustible cigarette smokers. Participants ($n = 577$; $M_{age} = 44.42$; 52.7% female) were adult daily smokers recruited to participate in an online survey. Smoking for weight/appetite control was assessed via the four subscales of the Smoking-Related Weight and Eating Episodes Test (SWEET). Results indicated that higher scores on two SWEET subscales were significantly associated with increased odds of current e-cigarette use: smoking to suppress appetite (OR = 1.356, CI_{95%} = 1.116-1.646, $p = .002$) and smoking to prevent overeating (OR = 1.314, CI_{95%} = 1.101-1.567, $p = .002$). These effects were significant after adjusting for sex, age, compensatory eating behavior, body mass index, and tobacco dependence. Scores on the other two SWEET subscales (smoking to cope with body dissatisfaction and with appetite-related withdrawal) were not significantly associated with current e-cigarette use. These findings indicate that daily cigarette smokers who use cigarettes to manage their appetite and eating behavior may be more likely to use e-cigarettes, potentially because e-cigarettes will also serve this function. Future research should evaluate reasons for this association, including beliefs about e-cigarettes in management of appetite and eating behavior, and the acute effects of e-cigarettes on body weight and eating behavior relative to combustible cigarettes.

Keywords

electronic cigarettes; e-cigarettes; cigarette smoking; tobacco; weight

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Introduction

Many people who smoke cigarettes, especially women, report that weight control is a motive for cigarette smoking (Pinto et al., 1999; White, 2012) and that concern about gaining weight is a significant barrier to quitting smoking (Beebe and Bush, 2015; Clark et al., 2006; Pomerleau, Zucker, & Stewart, 2001). Nicotine suppresses appetite and increases metabolism, and also serves as a behavioral alternative to eating or a distraction from hunger or food craving (Audrain-McGovern and Benowitz, 2011). Indeed, quitting smoking reverses these effects and is accompanied by weight gain for 80% of quitters (Aubin, Farley, Lycett, Lahmek, & Aveyard, 2012).

Against this backdrop is the rapidly increasing popularity of electronic cigarettes (e-cigarettes) (Schoenborn and Gindi, 2015). E-cigarettes are battery-powered devices that contain a liquid solution of humectant and nicotine. Inhalation triggers the liquid to be heated by the battery and vaporized; this vapor is then exhaled as an opaque aerosol that resembles cigarette smoke. E-cigarettes are distinguished by their potential ability to replicate both the pharmacological and sensorimotor aspects of smoking combustible cigarettes (Cahn and Siegel, 2011). Indeed, one of the most commonly reported reasons for using e-cigarettes is to aid in cessation of combustible cigarette use (Glasser et al., 2017). However, although some individuals do succeed in switching from smoking combustible cigarettes to exclusive e-cigarette use (“vaping”), the majority of e-cigarette users continue to smoke combustible cigarettes (“dual users”) (Bao, Xu, Lu, Snetselaar, & Wallace, 2018; Glasser, et al., 2017).

Evaluating the safety of e-cigarettes has been complicated by diverse and rapidly evolving product designs, quality control issues in manufacturing, and regulatory policies. The short-term health risks of e-cigarette use appear to be substantially lower than smoking combustible cigarettes, but the long-term consequences are not yet known (Glasser, et al., 2017). Furthermore, dual use has less potential benefit than exclusive vaping (Adriaens, Van Gucht, & Baeyens, 2018; Maglia, Caponnetto, Di Piazza, La Torre, & Polosa, 2018; Robertson et al., in press), given that even low-level smoking of combustible cigarettes is associated with significant health risks (Bjartveit and Tverdal, 2005; Inoue-Choi et al., 2017; Tverdal and Bjartveit, 2006).

Reports are now emerging that some individuals are using e-cigarettes for weight control (Morean and Wedel, 2017). Moreover, some e-cigarettes are already being actively marketed for weight management and/or suppression of food cravings (Morean and Wedel, 2017). Between 2004-2015, 23 patents were filed related to adding weight loss medications to e-cigarette liquids or developing other technologies for using e-cigarette devices to support weight loss (Singh, Kennedy, Lagasse, Czaplicki, & Cohen, 2017).

In the current study, we evaluated whether there was an association between the tendency to use combustible cigarettes to control weight and appetite concerns and current e-cigarette use, among daily combustible cigarette smokers. There are a number of reasons why smokers may rely on cigarettes to manage weight and appetite-related concerns, including to suppress appetite or prevent overeating by using cigarettes as a behavioral substitute for

eating, to cope with body dissatisfaction, or to manage weight or appetite changes due to nicotine withdrawal symptoms. These different reasons may demonstrate unique associations with e-cigarette use. Therefore, the current study aimed to provide an initial test of the associations between reasons for relying on combustible cigarettes to manage weight and appetite-related concerns and current e-cigarette use among daily smokers. Based on prior findings, we hypothesized that smokers who reported a greater tendency to use cigarettes for managing weight and appetite concerns would be more likely to use e-cigarettes than smokers for whom weight control is a less important motive for smoking.

Methods

Participants and Procedure

Participants (N=577; 52.7% female) were daily smokers recruited through Qualtrics Online Sample for an anonymous study on emotional factors contributing to smoking and health (manuscript under review). In the current study, we conducted a secondary analysis of the baseline data from this study. The present analyses are unrelated to the primary aim of the parent study.

Data were collected through the Qualtrics participants pool based on pre-specified criteria of being 18 years of age and a daily smoker. Data collection was managed by Qualtrics Panels service. Qualtrics Panels utilizes “burst” sampling with replacement, to disperse the survey to participants meeting these preliminary criteria. Interested participants then completed a screening survey to determine eligibility which included: being 18 years of age, a daily smoker for 1 year, smoking 5 cigarettes/day, and reporting that they used combustible cigarettes as their primary tobacco product. Participants were excluded if they reported reducing their smoking rate by more than half in the past 6 months. Participants were unaware of the specific inclusion/exclusion criteria. The criteria used are common and standard for studies involving daily cigarette smokers in which the purpose is to examine mechanisms that maintain tobacco use, as was the goal of the parent study. The survey was approximately 40 minutes in length. The study protocol was approved by the Institutional Review Board where the study was conducted. Informed consent was obtained from all individual participants included in the study. All procedures were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

A total of 3,113 individuals completed the screening, and 1,316 were eligible for the study. All eligible participants completed the survey. Cases were excluded from analysis if any of four embedded validity ‘check’ questions were answered incorrectly (n = 697). Of the remaining 619 cases, 30 were excluded from the current analyses because of providing invalid self-reported height and weight (i.e., incorrectly entered data/misunderstanding of instructions) and 12 were excluded because they reported <70% confidence in the accuracy of self-reported height and/or weight. Therefore, 577 participants were included in the current analyses. Participants received compensation in the form of Qualtrics credits which can be used to purchase gift cards or other items through the Qualtrics Panels portal.

Measures

Items from the *Smoking History Questionnaire* (SHQ) (Brown, Lejuez, Kahler, & Strong, 2002) were used to describe the sample in terms of smoking pattern (e.g., number of cigarettes per day). Participants were also asked: “Do you currently use electronic cigarettes?” [Yes/No] and whether they had used e-cigarettes to aid in smoking cessation [Yes/No]. Participants who said they were currently using e-cigarettes indicated how many times per day and how soon after waking they used their e-cigarette, how often they filled their e-cigarette, and how many milligrams of nicotine they put in their e-cigarette.

Tobacco dependence was assessed with the 6-item *Fagerström Test for Cigarette Dependence* [FTCD] (Fagerstrom, 2012), with higher scores reflecting higher dependence (possible range 0-10).

The *Smoking-Related Weight and Eating Episodes Test* (SWEET) (Adams, Baillie, & Copeland, 2011) is a 10-item self-report measure that was used to assess the extent to which individuals smoke for specific reasons related to eating and weight concerns. Each item is rated on a 5-point Likert scale ranging from 1 (*Never*) to 5 (*Always*). The multidimensional nature of the SWEET items has been validated in male and female smokers (Farris, DiBello, Bloom, & Abrantes, 2018), yielding four interrelated subscales: smoking to suppress appetite, prevent overeating, cope with body dissatisfaction, and cope with appetite-related withdrawal. In the current sample, SWEET subscales were highly correlated (r 's = .58 - .71, p 's < .001),

Body Mass Index (BMI) was calculated based on self-reported weight and height ($[\text{weight}(\text{lbs})/[\text{height}(\text{in})]^2 \times 703]$). Perceived accuracy in self-reported height and weight was rated on a 0-100% scale of accuracy confidence. As noted above, cases with accuracy confidence > 70% were retained; average accuracy ratings were very high for height ($M = 98.0\%$ ($SD = 4.13\%$)) and weight ($M = 96.6\%$, $SD = 5.16\%$).

The *Patient Health Questionnaire* (PHQ) (Spitzer, Kroenke, & Williams, 1999) was used to assess the presence/absence of compensatory eating behaviors (vomiting, misuse of laxatives, fasting/not eating, and/or over-exercising) during the past 3 months.

Data Analytic Procedures

Analyses were conducted in SPSS v24.0. Differences between smokers with and without current e-cigarette use (0=No, 1=Yes) were explored in relation to demographics, smoking and weight-related variables, and SWEET subscale scores. In order to test the association between each SWEET subscale and e-cigarette use, we constructed four hierarchical logistic regression models. In each model, we controlled for sex, age, compensatory eating behavior, body mass index, and tobacco dependence. These covariates were determined *a priori* based on their theoretical relevance to SWEET and e-cigarette use. In step 2 of the models, the SWEET subscale was entered. This hierarchical approach allows for testing the unique effect of the SWEET subscale above and beyond the effects of the model covariates. A Bonferroni corrected alpha was used to adjust for multiple analyses ($\alpha = .05 \div 4 \text{ analyses} = .0125$).

Results

Participants ($n = 577$; $M_{\text{age}} = 44.42$; $SD = 13.80$; 52.7% female) were primarily white (90.1%), married (49.2%) or never married (27.7%), and had completed at least some college (71.4%). Approximately one-fourth of the sample reported current use of e-cigarettes ($n = 158$, 27.4%), of which 52.9% reported use of e-cigarettes in the past to aid in a quit attempt. Sample characteristics are presented in Table 1.

Among current e-cigarette users ($n = 158$), participants used their e-cigarette a mean of 4.65 times per day ($SD = 6.74$) and use of their e-cigarette after waking was reported as occurring within 5 minutes (13.9%), within 6-30 minutes (21.5%), within 31-60 minutes (13.9%), and after 60 minutes (50.6%). The association between number of cigarettes smoked per day and number of e-cigarette uses per day was non-significant. The majority of e-cigarette users reported filling their e-cigarettes every three days or more (60.8%), and fewer reported filling it every two days (15.2%), daily (15.2%), or more than once per day (8.9%). There was variability in the number of milligrams of nicotine used in e-cigarettes: 36 mg (3.8%), 24 mg (11.4%), 18 mg (16.5%), 11 mg (18.4%), 8 mg (17.7%), 4 mg (22.2%), and 0 mg (i.e., nicotine free, 10.1%).

Hierarchical logistic regression analyses revealed significant fit for all four models, with classification accuracy ranging from 73% - 74% across models. Regarding covariates, step 1 of the models revealed that the presence of compensatory eating symptoms was associated with significantly higher odds of current e-cigarette use ($OR = 2.050$ [$CI_{95\%} = 1.223 - 3.434$], $p = .006$). Non-significant covariate effects were observed for age ($OR = 0.989$ [$CI_{95\%} = 0.975 - 1.002$], $p = .106$), female sex ($OR = 0.727$ [$CI_{95\%} = 0.499 - 1.057$], $p = .095$), level of tobacco dependence ($OR = 1.086$ [$CI_{95\%} = 0.986 - 1.196$], $p = .095$), and BMI ($OR = 0.981$ [$CI_{95\%} = 0.955 - 1.008$], $p = .161$).

Regarding SWEET subscales, Smoking to Suppress Appetite was associated with significantly higher odds of current e-cigarette use ($OR = 1.356$ [$CI_{95\%} = 1.116-1.646$], $p = .002$). Smoking to Prevent Overeating was also associated with significantly higher odds of current e-cigarette use ($OR = 1.314$ [$CI_{95\%} = 1.101-1.567$], $p = .002$). Smoking to Cope with Body Dissatisfaction was not significantly related to odds of current e-cigarette use at the correlated alpha level ($OR = 1.217$ [$CI_{95\%} = 1.034-1.433$], $p = .018$). Smoking to Cope with Appetite-Related Withdrawal was not significantly related to odds of current e-cigarette use.

Discussion

As electronic cigarettes (e-cigarettes) increase in popularity among current and former cigarette smokers (Schoenborn and Gindi, 2015), emerging data indicate that e-cigarettes are being used for managing weight concerns (Morean and Wedel, 2017). Consistent with our hypothesis, findings in the current study indicated that compared to daily smokers who were not using e-cigarettes, daily smokers who were also currently using e-cigarettes had higher scores on the two SWEET subscales most directly relevant to weight/appetite control: 1) smoking to suppress appetite and 2) smoking to prevent overeating. There was no significance difference between e-cigarette users and non-users on the other two SWEET

subscales (smoking to cope with body dissatisfaction and with appetite-related withdrawal). These findings suggest it is possible that individuals who utilize cigarettes to suppress their appetite and/or prevent overeating may find e-cigarettes especially appealing and believe that e-cigarettes will serve these functions as effectively as combustible cigarettes.

Given that weight control is a common motive for smoking (Pinto, et al., 1999; White, 2012), the current findings raise the possibility that weight-concerned smokers may turn to e-cigarettes as another method of weight control in addition to combustible cigarettes. It is notable that various behavioral and pharmacological interventions specifically targeted to weight-concerned smokers have been tested. However, for the most part, smoking and weight outcomes have not differed from standard treatments (Aubin, et al., 2012; Farley, Hajek, Lycett, & Aveyard, 2012).

This study had several limitations. We recruited a convenience sample online; participants were daily smokers relatively high in socioeconomic status and mostly White. Therefore, results may not apply to non-daily smokers and must be replicated in other, more representative samples. Second, current e-cigarette use was assessed with a single, dichotomous (yes/no) item. Third, all participants were daily combustible cigarette smokers (i.e., combustible cigarettes were their primary form of nicotine/tobacco use), and e-cigarette users and non-users did not differ in mean number of combustible cigarettes per day. Therefore, it is unknown the extent to which participants who were using e-cigarettes were attempting to substitute e-cigarettes for cigarettes, or whether they were using e-cigarettes explicitly for the purpose of weight control. Finally, while we measured participants' body mass index and controlled for it in our models, we did not measure self-perception of weight. Self-perception of weight may be discordant with actual weight (e.g., individual with normal body mass index perceives herself to be overweight) and can be predictive of behavior (Duncan et al., 2011). Future studies should collect more details about participants' smoking and e-cigarette use history, should include both current and former smokers, and inquire specifically about the use of e-cigarettes for weight control among individuals who have used cigarettes for weight control.

In conclusion, we found that current daily combustible cigarette smokers were more likely to report also currently using e-cigarettes if they had a stronger tendency toward using combustible cigarettes to suppress their appetite and/or prevent overeating. Future research should evaluate whether e-cigarettes may have a role to play in weight management in the context of tobacco use, and the effects of e-cigarettes on eating behavior relative to combustible cigarettes.

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Table 1.
Descriptive characteristics among smokers with and without current e-cigarette use

Variable	Total Sample (n = 577)	E-Cigarette Use (n = 158)	No E-Cigarette Use (n = 419)	X ² or t
Sex (n, % Female)	304 (52.7%)	74 (46.8%)	230 (54.9%)	2.99
Age (M, SD)	45.2 (13.85)	42.3 (13.46)	45.2 (13.85)	2.32*
Race (n, % Non-White)	57 (9.9%)	17 (10.8%)	40 (9.5%)	0.19
Marital Status (n, % Married)	284 (49.2%)	72 (45.6%)	212 (50.6%)	1.16
Tobacco dependence (M, SD)	5.3 (1.98)	5.6 (2.01)	5.3 (1.97)	-1.64
Cigarettes per day (M, SD)	17.0 (8.38)	17.8 (9.61)	16.6 (7.86)	-1.40
Years as a smoker (M, SD)	25.7 (14.35)	24.2 (15.20)	26.3 (13.99)	1.56
Prior Quit Hx (n, % Yes)	467 (80.9%)	133 (84.2%)	334 (79.7%)	1.48
Body Mass Index (M, SD)	27.9 (7.31)	27.3 (7.36)	28.2 (7.30)	1.23
Compensatory Eating Sx (n, % Yes)	77 (13.3%)	33 (20.9%)	44 (10.5%)	10.70**
SWEET Subscales (M, SD)				
Smoking for Appetite Suppression	2.4 (1.09)	2.7 (1.14)	2.3 (1.05)	-4.10***
Smoking to Avoid Overeating	2.3 (1.18)	2.6 (1.22)	2.2 (1.14)	-4.08***
Cope with Body Dissatisfaction	2.1 (1.26)	2.3 (1.35)	1.9 (1.21)	-3.21**
Cope with Appetite-Related Withdrawal Sx	2.6 (1.30)	2.8 (1.32)	2.5 (1.28)	-2.70**

* $p < .05$ ** $p < .01$ *** $p < .001$