



Worry, anxiety sensitivity, and electronic cigarettes among adults

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ABSTRACT

Although electronic cigarette (e-cigarette) use is now a common substance use behavior, there is little understanding of the individual difference factors related to e-cigarette use beliefs and dependence. The present investigation sought to test a theoretically-driven model of anxiety sensitivity as an explanatory element in a worry-e-cigarette beliefs and dependence model. Participants included 558 adult e-cigarette users (51.4% female; 35.2 years, $SD = 10.1$) who were nationally recruited via an online survey system. Participants completed a single survey that assessed their mood and e-cigarette behavior and beliefs. Results supported a statistically significant indirect pathway for worry in relation to perceived benefits of e-cigarettes, e-cigarette positive outcome expectancies, and e-cigarette dependence via anxiety sensitivity; effect sizes were small. The indirect effects were evident when accounting for several theoretically relevant covariates (sex, income, education, concurrent cigarette use, and neuroticism). This study provides the first empirical evidence of the role of anxiety sensitivity in the relation between worry and e-cigarette use beliefs and behavior, which may represent a novel intervention target.

1. Introduction

Electronic cigarettes (e-cigarettes) are now a prevalent form of substance use in the United States as well as other parts of the world (e.g., adolescents, persons with mental illness; Cummins et al., 2014; Delnevo et al., 2015). Available research indicates that individuals may use e-cigarette to reduce their reliance on smoking (tobacco) products (Dawkins et al., 2012), among other reasons (e.g., social acceptability; Sussan et al., 2017). In fact, smokers may hold the belief that e-cigarettes are less harmful to their bodies than cigarettes (Dawkins et al., 2012). However, the actual degree of relative benefit of e-cigarettes versus cigarettes is not presently clear (Callahan-Lyon, 2014; Pisinger and Døssing, 2014) and there are demonstrable risks related to e-cigarette use; (e.g., inhaling toxins, increased risk of respiratory disease; Callahan-Lyon, 2014; Dinakar & O'Connor, 2016).

E-cigarette use may not be equally distributed in the general population. Some research has indicated that e-cigarette use may be two to three times higher in individuals with a psychiatric disorder compared to persons without a psychiatric disorder (Cummins et al., 2014). Because individuals with psychiatric conditions or elevated psychiatric symptoms are more apt to be smokers and struggle to quit successfully (Ziedonis et al., 2008; Zvolensky et al., 2017), e-cigarettes are posited to be a particularly attractive option for this population (Prochaska and

Grana, 2014). Although e-cigarettes may be a viable cessation option for smokers with mental illness, the rate of combustible cigarette use remains high among this population (27.8%; Cummins et al., 2014). The rate of e-cigarette use, however, is on the rise with 14.8% of smokers with mental illness reporting having used an e-cigarette (Cummins et al., 2014). Unfortunately, little is known about individual differences in psychological vulnerability and e-cigarette use processes and behavior.

One individual difference factor implicated in vulnerability for common forms of psychiatric disorders is worry. Worry is commonly operationalized as repetitive thoughts focused on the possibility of future negative events (Borkovec, 1994), which frequently serves as a cognitive avoidance tactic (Borkovec et al., 1998). Worry is a broad-band diathesis and long-considered a 'formative element' to anxiety and related mood psychopathology (Barlow et al., 2002). Although worry is related to negative mood states, decades of research suggest it is a distinct construct (Borkovec et al., 1998). To date, we are not aware of any empirical work on worry and its association with e-cigarette use processes and behavior. Research with cigarette smokers indicates that the propensity to worry is related to coping motives, negative reinforcement expectancies, greater perceived barriers for smoking cessation, and cessation-related problems (Farris et al., 2016; Peasley-Miklus et al., 2012). Further, clinical worry, exemplified by a diagnosis

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of Generalized Anxiety Disorder (GAD), is associated with an increased risk of smoking, tobacco dependence, and decreased success in quitting (Goodwin et al., 2012; Lasser et al., 2000; Piper et al., 2010). Based upon such work, there is utility in exploring worry in relation to e-cigarette use processes implicated in theories of e-cigarette use, such as perceived benefits of e-cigarettes, positive outcome expectancies, and e-cigarette dependence.

Although worry may theoretically be related to e-cigarette use belief and behavior, it also is important to explicate the mechanisms in such relations. A promising construct to better understand the worry-e-cigarette relationship is anxiety sensitivity. Anxiety sensitivity (AS) is an individual difference factor related to the expectations of personal threat in response to aversive internal states (Reiss et al., 1986). AS is empirically and theoretically distinguishable from the propensity to experience negative affect (Zvolensky et al., 2005) and worry (Olvera et al., 2014). Decades of research have found that AS increases the risk for more severe anxiety and depressive symptoms (Hayward et al., 2000; Schmidt et al., 2006). AS also has been identified as a risk vulnerability for more maladaptive cognitive processes of e-cigarette use and difficulty quitting e-cigarettes (Zvolensky et al., 2018b). Further, more recent work has found that AS may operate as a mechanism in smoking behavior, including smoking cessation (Zvolensky et al., 2018a), cognitive processes (e.g., motives for cigarette use, perceived barriers for quitting; Zvolensky et al., 2014), and various aspects of smoking behavior (e.g., withdrawal; Bakhshaei et al., 2018). Indeed, prior work has identified AS as an explanatory variable between worry and smoking outcomes, including number of years being a daily smoker, latency to first cigarette of the day, smoking rate, heaviness of smoking, and nicotine dependence (Olvera et al., 2014). The degree to which these process-oriented pathways can be generalized to other groups of nicotine users, including e-cigarette users, remains unknown.

Consistent with negative reinforcement models of combustible cigarette use (Baker et al., 2004), e-cigarette users may use e-cigarettes to reduce negative affect and craving related to stress and withdrawal symptoms, which may be exacerbated by high levels of worry and anxiety sensitivity. Moreover, it is possible that e-cigarette users who are more prone to worry may be more sensitive to visceral or interoceptive states and catastrophize these experiences. These symptoms may, in part, be the consequence of e-cigarette use, as e-cigarette use produces an array of somatic sensations (e.g., respiratory symptoms, nicotine withdrawal symptoms, inflammation; McCauley et al., 2012; Bold et al., 2018; Wang et al., 2016). Thus, theoretically, worry may lead to heightened AS, and these e-cigarette uses may be more included to engage in more severe use patterns to manage their negative affective symptoms and hold more maladaptive beliefs about e-cigarette. Thus, this conceptual model outlines the potential for AS to explain relations between worry and theoretically-relevant aspects of e-cigarette use, including greater risk for dependence (e.g., more likely to rely on e-cigarettes), perceived benefits of e-cigarette use (e.g., safety of e-cigarettes), and expectancies that e-cigarette use will result in positive outcomes (e.g., e-cigarettes helpful in managing mood). This type of perspective is in line with ‘false safety’ perspective of anxiety-substance comorbidity, which posits substances function as short-term safety aids despite offering longer-term risks (Buckner et al., 2017, 2018). Additionally, given that e-cigarette benefits are often framed in terms of relative risk compared to combustible cigarette smoking, e-cigarette users who report greater worry and AS may be more apt to perceive more benefits of e-cigarettes. In part, this belief may be byproduct of stronger beliefs about the personal, negative consequences of combustible cigarette use held by individuals with elevated emotion vulnerability (Gregor et al., 2008; Garey et al., 2017).

With this background, the present study evaluated whether AS explained, in part, the relations between worry and several clinically significant e-cigarette use variables among a large sample of adult e-cigarette users. Primary criterion variables included perceived benefits of e-cigarettes (Farsalinos et al., 2014), e-cigarette positive outcome

expectancies (Goniewicz et al., 2013), and e-cigarette dependence (Etter and Eissenberg, 2015). We hypothesized that worry and AS would exert independent, direct effects on the dependent variables and that AS would explain the main effect of worry on outcomes. The hypothesized effects were expected to be evident above and beyond the variance attributable to an array of theoretically-relevant covariates, including sex, income, education, concurrent cigarette use, and neuroticism (King et al., 2013, 2014).

2. Method

2.1. Participants

The present study consisted of 558 adult past month e-cigarette users. Participants were recruited via an online survey and were eligible if they were between the ages of 18–64 years and reported past month e-cigarette use. Exclusion criteria included being younger than the age of 18 years, a non-English speaker (to ensure comprehension of the study questions), and an inability to give informed, and voluntary, written consent to participant.

Half of the participants were female (51.4%) and the mean age was 35.2 years ($SD = 10.1$). Most of the sample was White/Caucasian (75.6%), with 16.7% identifying as Black/African American, 3.9% Asian, 1.8% Native American/Alaska Native, 0.4% Hawaiian or other. In terms of education, about a quarter of the sample (23.5%) reported attaining a high school diploma, and 20.1% percent reported “some college,” and of the remaining sample 21.1% specified completing their bachelor's degree or higher. The median income bracket fell within the range of \$35,000 to \$49,999. Respondents indicated using their e-cigarettes an average of 8.1 times a day ($SD = 9.8$) and an overall low level of e-cigarette dependence was observed in the sample (Foulds et al., 2014). Participants reported an average of 2.7 ($SD = 3.1$) serious attempts to quit e-cigarette use in their lifetime. Approximately 77.1% indicated concurrent combustible cigarette use. Of the concurrent users, individuals indicated smoking an average of 13.3 ($SD = 17.3$) cigarettes per day and being a daily smoker for an average of 15.9 years ($SD = 10.8$).

2.2. Measures

Demographics Questionnaire. Participants provided demographic information regarding their sex (0 = Male, 1 = Female), race, age, educational level (1 = Grade 6 or less to 8 = Graduate or professional degree), and annual income (1 = \$0–\$4,999 to 8 = \$75,000 or higher). Demographic information was used to characterize the sample. Sex, income and education were included as covariates.

Electronic Cigarette Smoking History Questionnaire. The Electronic Cigarette Smoking History Questionnaire (EC-SHQ) is a 28-item self-report measure developed by the current research team and successfully utilized in previous e-cigarette smoking studies (Zvolensky et al., 2018b). The measure includes modified items borrowed from the Smoking History Questionnaire (Brown et al., 2002) and select items from a large, national study on e-cigarette use (Foulds et al., 2014). The EC-SHQ was developed to assess electronic cigarette smoking history and includes items pertaining to age of onset, frequency of use, past quit attempts, and concurrent combustible cigarette use.

Penn State Worry Questionnaire. The Penn State Worry Questionnaire (PSWQ; (Meyer et al., 1990) is a 16 item self-report measure used to assess worry. Each item is rated on a 5-point Likert scale ranging from 0 (*not at all typical of me*) to 4 (*very typical of me*). An example item from this measure includes “I know I should not worry about things, but I just cannot help it.” This scale has demonstrated good psychometric properties, including internal consistency, test-retest reliability, and discriminate validity (Behar et al., 2003; Brown et al., 1992; Fresco et al., 2003; Meyer et al., 1990). A total PSWQ score was used for the present study and yielded good internal consistency ($\alpha = 0.87$).

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