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Short Communication

Comparing cigarette and e-cigarette dependence and predicting frequency of smoking and e-cigarette use in dual-users of cigarettes and e-cigarettes

Meghan Morean^{a,b,*}, Suchitra Krishnan-Sarin^b, Stephanie S. O'Malley^b^a Department of Psychology, Oberlin College, 120 W Lorain St., Oberlin, OH 44074, United States^b Department of Psychiatry, Yale School of Medicine, 34 Park Street, New Haven, CT 06519, United States

HIGHLIGHTS

- Most e-cigarette (ecig) users also smoke tobacco cigarettes (i.e., are dual-users).
- Dual-users could discriminate between dependence on cigarettes and e-cigs.
- Dual-users reported stronger dependence on cigarettes than on e-cigs.
- Ecig dependence predicted increased ecig but decreased cigarette use frequency.
- Cigarette dependence predicted increased cigarette but decreased ecig use frequency.

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ABSTRACT

Introduction: The 4-item Patient-Reported Outcomes Measurement Information System Nicotine Dependence Item Bank is a psychometrically sound measure for assessing cigarette (PROMIS) and e-cigarette dependence (PROMIS-E). We evaluated whether dual-users of cigarettes and e-cigarettes self-report experiencing different levels of dependence on each product. We subsequently examined whether cigarette and e-cigarette dependence are associated with the frequency of using each product in dual-users.

Methods: Dual-users completed an online survey in Summer 2017 (n = 326; 49.7% male, 85.3% White, mean age 38.17 [13.08] years). Measurement invariance of the PROMIS and PROMIS-E was evaluated. Mean differences in cigarette and e-cigarette dependence then were examined. The correlation between cigarette and e-cigarette dependence also was examined. Finally, one-way MANOVA was used to evaluate how cigarette and e-cigarette dependence relate to past-month frequency of e-cigarette use and cigarette smoking.

Results: The PROMIS and the PROMIS-E were scalar measurement invariant, and, on average, dual-users reported stronger dependence on cigarettes than on e-cigarettes. Cigarette and e-cigarette dependence were related, yet distinct constructs ($r = 0.35$), suggesting that dual-users can discriminate between dependence on each product. Stronger cigarette dependence predicted more frequent past-month smoking and less frequent past-month vaping. Stronger e-cigarette dependence predicted more frequent past-month vaping and less frequent smoking.

Conclusions: Overall, dual-users reported stronger dependence on cigarettes than on e-cigarettes. However, dependence on each product was associated with increased use of each respective product and with less frequent use of the other product. Future research using the PROMIS can evaluate how potential FDA regulations could reduce nicotine dependence across products.

1. Introduction

Tobacco cigarettes remain the most commonly used tobacco product among American adults, but e-cigarettes recently have gained popularity, especially among former smokers and current smokers (i.e., “dual-users”) (King, Patel, Nguyen, & Dube, 2014). Recent estimates

suggest that 17.4% of American adults currently smoke cigarettes and 5.4% use e-cigarettes (El-Shahawy et al., 2018). Although the negative health effects of and risk for developing dependence on tobacco cigarettes are well-documented (US Department of Health and Human Services, 2014), the potential negative health effects of using e-cigarettes (i.e., “vaping”), including their addictive potential, are not well-

* Corresponding author at: Department of Psychology, Oberlin College, 120 W Lorain St., Oberlin, OH 44074, United States.
E-mail address: Meghan.Morean@oberlin.edu (M. Morean).

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established (US Department of Health and Human Services, 2016).

To date, few studies have examined e-cigarette dependence relative to cigarette dependence. Although nicotine e-cigarette use can produce peak nicotine levels comparable to smoking cigarettes (Marsot & Simon, 2016), research suggests that e-cigarette users experience vaping as producing less severe dependence (Etter & Eissenberg, 2015; Farsalinos, Romagna, Tsiapras, Kyrzopoulos, & Voudris, 2013; Foulds et al., 2014; González, Secades, & Weidberg, 2017; Liu, Wasserman, Kong, & Foulds, 2017; Strong et al., 2017). However, several limitations of extant research should be noted. First, prior studies largely have relied on measures/indices of dependence that were not validated for use with both cigarettes and e-cigarettes (e.g., The Penn State E-cigarette Dependence Index (Foulds et al., 2014); the Fagerstrom Test of Nicotine Dependence (Etter & Eissenberg, 2015; González et al., 2017); shorter time to first morning use (Farsalinos et al., 2013; Liu et al., 2017)). Furthermore, two studies relied on retrospective reports of cigarette dependence made by current e-cigarette users who were former smokers (Foulds et al., 2014; González et al., 2017). Although this approach may not be inherently invalid, it potentially raises concerns about accurate recall or about former smokers' favorable bias toward e-cigarettes, which are perceived as being safer than cigarettes (Farsalinos et al., 2013). Finally, although data from the nationally representative PATH study were used to compare nicotine dependence across a range of tobacco products including e-cigarettes in a sample of current product users (Strong et al., 2017), the measure that was used to assess dependence has limitations. For example, several items assess concepts that previously have been shown to be distinct from, albeit related to, nicotine dependence, including coping expectancies ("Using [product] would really help me feel better if I've been feeling down") and emotional/sensory expectancies or cognitive enhancement ("Using [product] helps me think better") (Edelen et al., 2014). In addition, different time frames are employed to assess users' experiences. For example, one item assesses past-year experiences ("In the past 12 months, did you find it difficult to keep from using [product] in places where it was prohibited") while others have a present focus ("I frequently crave [product]"). Finally, while dual-users of cigarettes and e-cigarettes answered dependence questions related to both products, it is not clear how the dependence score for dual-use was computed (e.g., a mean of both dependence scores).

Recently, the Patient-Reported Outcomes Measurement Information System (PROMIS) Nicotine Dependence Item Banks (22-item, 8-item, 4-item), which originally were developed and validated for assessing cigarette dependence (Edelen et al., 2014; Shadel et al., 2014), were validated for assessing e-cigarette dependence in samples of exclusive e-cigarette users and among dual-users of both cigarettes and e-cigarettes (Morean et al., 2018). Importantly, dual-users reported stronger e-cigarette dependence than exclusive e-cigarette users, and all e-cigarette users who reported using nicotine e-liquid reported stronger dependence than individuals using nicotine-free e-liquid (Morean et al., 2018). However, the original PROMIS (cigarette dependence) was not administered in this earlier study, so direct comparisons of e-cigarette and cigarette dependence could not be conducted.

The current study uniquely was designed to use the PROMIS and PROMIS-E to examine differences in self-reported dependence on cigarettes and e-cigarettes, respectively, in a sample of dual-users of both products. Of note, we chose to focus on dual-users because nationally representative data suggest that the majority of e-cigarette users also are cigarette smokers (Sharapova, Singh, Agaku, Kennedy, & King, 2018). Previous research indicates that the 4-item measure performs comparably to the longer versions in terms of predicting e-cigarette use outcomes (e.g., percent of variance accounted for in past 30-day vaping frequency [4-item 5%, 22-item 6%]) (Morean et al., 2018), so the current study focuses on the 4-item version.

Prior to examining differences in self-reported cigarette and e-cigarette dependence in dual-users, we conducted measurement invariance analyses to ensure that making mean-level comparisons of

cigarette and e-cigarette dependence was justified statistically. The magnitude of the relationship between cigarette and e-cigarette dependence was then examined as an indicator of whether dual-users could distinguish cigarette from e-cigarette dependence. Finally, research indicates that cigarette dependence is associated with increased smoking frequency (US Department of Health and Human Services, 2014) and that e-cigarette dependence is associated with increased vaping frequency (US Department of Health and Human Services, 2016). The present study uniquely examined how dual-users' cigarette and e-cigarette dependence relate to the frequency of using each product when they are entered simultaneously as predictors.

2. Materials and methods

2.1. Participants

Adult e-cigarette users (N = 610) completed an anonymous, 20-minute, online survey. The analytic sample comprised the subsample of dual-users who reported using e-cigarettes and cigarettes at least weekly (n = 326; 49.7% male, 85.3% White, mean age 38.16 [13.09] years, smoking frequency = 22.32 [9.58] days/month, vaping frequency = 22.39 [8.33] days/month).

2.2. Procedures

The Yale School of Medicine Institutional Review Board exempted the study. Participants were recruited by Qualtrics Online Sample, the research division of Qualtrics, Inc. To become a panelist, individuals voluntarily applied via the Qualtrics website and completed a "profiling" demographic survey. Qualtrics sent recruitment emails to panelists who were likely to be eligible based on their responses to previous surveys (e.g., smoking status). Interested panelists clicked on a link and completed the study eligibility questions. Participants provided consent to participate and were compensated based on the terms of their agreements with Qualtrics.

2.3. Measures

Participants completed eligibility questions followed by questions assessing demographics, cigarette, and e-cigarette use. Remaining questionnaires (e.g., PROMIS; PROMIS-E) were completed in randomized order.

2.3.1. Screener questions (E-cigarette and cigarette use) (Morean et al., 2018)

Participants completed several filler questions to obscure the study aims (e.g., vegetable consumption). Two screening questions were used to determine eligibility. First, participants had to report vaping at least weekly on the following question: "On average, how often do you use electronic cigarettes (also known as vaping)?" Response options included "never, 1-2 times per year, or 3-11 times per year, once a month, 2-3 times a month, once a week or more." To continue the survey, participants also had to provide a consistent response on the following question, which was presented later in the survey: "During the past 30 days, on how many days did you use an e-cigarette/vape? (must respond \geq 4). All participants also answered a screener question assessing cigarette smoking status: "Which of the following best describes you?" "I have never smoked a cigarette," "I am a former smoker, but I successfully quit smoking," "I smoke cigarettes occasionally - at least once a month," or "I smoke cigarettes daily." To be considered a dual-user for the current study, participants had to endorse smoking on the screener and report smoking an average of at least once a week on following question that was asked later in the survey: "During the past 30 days, on how many days did you use an e-cigarette/vape?" (must respond \geq 4).

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