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# Substance Use among Exclusive Electronic Cigarette Users and Dual Combustible Cigarette Users: Extending Work to Adult Users

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## Abstract

**Background:** Electronic cigarettes (e-cigarettes) have become increasingly popular in recent years. Existing evidence indicates e-cigarettes used in isolation are less harmful than combustible cigarettes, yet emerging work has demonstrated that adults use e-cigarettes largely in combination with combustible cigarettes (i.e. dual use). Despite this data, little is understood about how exclusive and dual e-cigarette users may differ across behavioral outcomes, such as substance use dependence and behaviors among adults.

**Objectives:** Thus, the current project examined differences in e-cigarette dependence, problematic alcohol use, cannabis use, and nonmedical prescription opioid use (e.g. methadone and oxycodone) across both exclusive and dual e-cigarette adult users.

**Results:** Participants included 531 (53.6% female; $M_{age}$ = 35.29 years, SD = 10.44) adults with past-month e-cigarette use. Dual users reported greater e-cigarette dependence, alcohol use, current cannabis use, and endorsement of nonprescription opioid use.

**Conclusions/Importance:** Importantly, this work suggests that adults who use both combustible and e-cigarettes may constitute a group more vulnerable to experiencing problematic substance use and more severe e-cigarette dependence than exclusive e-cigarette users.

### Keywords

Dual combustible cigarette user; nicotine dependence; alcohol use; cannabis; nonprescription opioids

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Declaration of interest

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## Introduction

Recent years have been marked by an increase in electronic cigarette (e-cigarette) use among adolescent and adult populations (Choi & Forster, 2013; Dutra & Glantz, 2014; Zhu et al., 2017). The rapid uptake of e-cigarette use among adults is, in part, due to the viewpoint that e-cigarettes are less harmful than combustible cigarettes (Benowitz et al., 2017; Brikmanis et al., 2017) and can assist with combustible cigarette reduction or cessation (Patel et al., 2016; Warner & Mendez, 2019). Indeed, some evidence has suggested e-cigarettes are less harmful than combustible cigarettes because e-cigarettes do not include combustion, which is the key process that produces harmful chemicals in combustible cigarettes (Abrams et al., 2018; Azzopardi et al., 2016; Hecht et al., 2015; Royal College of Physicians of London, 2016). Additionally, although evidence is mixed (Benmarhnia et al., 2018; Chadi et al., 2019; Hartmann-Boyce et al., 2018; Jackson et al., 2020), there is some support for e-cigarettes to assist with combustible cigarette reduction or cessation (Borrelli & O'Connor, 2019; Farsalinos & Niaura, 2020). As such, many adult users initiate e-cigarette use to reduce their harm exposure or to reduce or quit combustible cigarette use (Abrams et al., 2018; Farsalinos & Polosa, 2014). Nonetheless, e-cigarette use carries health risks, including exposure to harmful toxins and aerosols, and increased risk for cardiovascular disease (Bold et al., 2018) and respiratory illness (Layden et al., 2020; Viswam et al., 2018). Further, many adult smokers who initiate e-cigarette use become dual-users (i.e. using both e-cigarettes and combustible cigarettes) (Barrington-Trimis et al., 2016; Spindle et al., 2017). Indeed, 40.8% of current adult e-cigarette users report dual combustible cigarette use (Mirbolouk et al., 2018; Owusu et al., 2019). This pattern of nicotine use is a major public health concern because dual users are exposed to toxins and constituents, including carcinogens, at levels comparable to exclusive combustible cigarette smokers (Shahab et al., 2017), and are at risk for prolonged combustible cigarette use, a key determinant in the development of lung and other types of cancer (Chaffee, 2019; Goniewicz et al., 2018; Shahab et al., 2017). As with other behaviors of dual or poly-substance use (Dunbar et al., 2017; Kelly et al., 2017; Sung et al., 2018; Timko et al., 2018), dual combustible and e-cigarette use also may confer worse behavioral health outcomes. Yet, little work has evaluated how exclusive and dual e-cigarette using adults may differ in such factors, such as e-cigarette dependence and other types of substance use.

Emerging evidence has indicated a strong link between e-cigarette use and poly-substance use among adolescent and young adult samples. For example, e-cigarette use is associated with higher rates of alcohol and illicit substance use (e.g. cocaine, inhalants, hallucinogens) as well as misuse of over-the-counter and prescription medications among young adults aged 18–23 years and university students (Grant et al., 2019; Leventhal et al., 2016; Littlefield et al., 2015; Temple et al., 2017). Additionally, e-cigarette use is strongly related to increased cannabis use among young adults aged 18–24 years and high school students (Chadi et al., 2019; Saddleson et al., 2015; Sutfin et al., 2013; Trivers et al., 2018). Moreover, dual combustible and e-cigarette using adolescents are more likely to use greater amounts of cannabis, alcohol, and other illicit substances compared to exclusive e-cigarette users and non-users (Kristjansson et al., 2015; Wills et al., 2015), a pattern that extends to both current and lifetime substance use (Curran et al., 2018). Additionally, dual use serves as an indicator

of more severe nicotine dependence among adolescents, young adults, and older adults (Dugas et al., 2020; Martínez et al., 2020 (Bowe et al., 2021). To date, however, no work has explicitly evaluated if adult dual and exclusive e-cigarette users differ on patterns of substance use across various substances or if facets of e-cigarette dependence differ across adult dual and exclusive e-cigarette users.

Considering the prevalence of dual use among adults (Mirbolouk et al., 2018; Owusu et al., 2019), and the potential for this behavior to serve as a risk factor (or profile indicator) for substance use among younger populations (Kristjansson et al., 2017; McCabe & West, 2017; Westling et al., 2017), an investigation into substance use behavior and dependence levels are needed to understand the extent to which these patterns exist among adults. Such work could aid in informing theoretical models of dual and exclusive e-cigarette use and intervention efforts aimed to address nicotine addiction.

The current study examined differences in substance use dependence and behavior across dual combustible and e-cigarette users and exclusive e-cigarette users. Outcomes of interest included e-cigarette dependence, problematic alcohol use, cannabis use, and nonmedical prescription opioid use. It was hypothesized that dual users would report higher level e-cigarette dependence, greater problematic alcohol use, greater cannabis use, and greater nonmedical prescription opioid use. Moreover, it was predicted that use of alcohol, cannabis, and nonmedical opioids would individually increase the likelihood for dual use status among adults. Post hoc analyses also were conducted the evaluate differences in item-level e-cigarette dependence across groups. Based on prior research (Du et al., 2019), we hypothesized dual and exclusive e-cigarette users would report comparable use frequency and latency to first e-cigarette and differ on all other items. Additionally, to provide a more in nuanced understanding for differences in facets e-cigarette dependence between dual and exclusive e-cigarette users, we examined e-cigarette dependence items individually.

## Materials and methods

### Participants

Participants were recruited from across the U.S. *via* Qualtrics Inc. Qualtrics Inc. is an online survey management system that has been found to yield valid and representative data. The present sample consisted of 531 (53.6% female; $M_{age}$ = 35.29 years, SD = 10.44) adult current e-cigarette users. Participants were recruited *via* an online survey and were eligible if they were between the ages of 18–65 years and reported past month e-cigarette use. Exclusion criteria included being younger than the age of 18 years and older than 65 years, a non-English speaker (to ensure comprehension of the study questions), and an inability to provide informed and voluntary written consent.

### 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.

**Smoking history questionnaire—**Select items were used from the Smoking History Questionnaire (SHQ) to assess combustible cigarette smoking history (Bonn-Miller & Zvolensky, 2009). Included items pertained to years of daily smoking and the average number of cigarettes smoked per day (Brown et al., 2002). The SHQ items were used to characterize the sample and have been successfully used in prior work among e-cigarette users (Zvolensky et al., 2019b).

**Electronic cigarette smoking history questionnaire—**The Electronic Cigarette Smoking History Questionnaire (EC-SHQ) is a 28-item self-report measure that assesses e-cigarette use history (Zvolensky et al., 2019b). This questionnaire includes items pertaining to frequency of use (e.g. Since you started regular daily e-cig use, how many times per day do you usually use your electronic cigarette?), age at onset, and dual combustible cigarette use (e.g. Do you currently use cigarettes? [1 = Yes, 2 = No]). The EC-SHQ has been successfully used in previous e-cigarette studies (Zvolensky et al., 2019a).

**Penn state electronic cigarette dependence index—**The Penn State Electronic Cigarette Dependence Index (PSECDI) is a 10-item self-report questionnaire used to assess e-cigarette dependence (Foulds et al., 2015). Participants are asked to provide information on the strength of urges to use (e.g. Do you ever have strong cravings to use an electronic cigarette?), waking and night use (e.g. Do you sometimes awaken at night to use your electronic cigarette?), number of times that an individual uses an e-cigarette (e.g. How many times per day do you usually use your electronic cigarette? [Assume that one “time” consists of around 15 puffs of lasts around 10 min.]), difficulty quitting (e.g. When you haven’t used an electronic cigarette for a while or when you tried to stop using, did you feel more irritable because you couldn’t use an electronic cigarette?), and experience of withdrawal symptoms (e.g. When you haven’t used an electronic cigarette for a while or when you tried to stop using, did you feel nervous, restless, or anxious because you couldn’t use an electronic cigarette?) are measured. The PSECDI total score demonstrated moderate internal consistency in this study.

**Marijuana smoking history questionnaire—**The Marijuana Smoking History Questionnaire (MSHQ) is a self-report instrument that measures respondents’ cannabis use history (Bonn-Miller & Zvolensky, 2009). Items from the MSHQ were used to assess cannabis smoking history status (e.g. Do you currently or have you ever smoked marijuana) and marijuana use in the last 30 days (e.g. Please rate your marijuana use in the past 30 days). The MSHQ has been successfully used in other studies (Buckner & Zvolensky, 2014; Manning et al., 2018; Mayorga et al., 2020).

**Alcohol use disorders identification test—**The AUDIT is a 10-item self-report measure used to screen for problematic alcohol consumption (Saunders et al., 1993). Questions (e.g. “How often do you have a drink containing alcohol”) are rated on various scales from 0 (never) to 4 (4 or more times a week). Items are summed to compute a total score, with higher scores representing more problematic drinking. The AUDIT has strong psychometric properties (Allen et al., 1997; Saunders et al., 1993). The AUDIT total score demonstrated excellent internal consistency in the present study ($\alpha$ = .93).

**Nonmedical prescription opioid use—**Nonmedical prescription opioid use was defined as a positive endorsement of non-medical use of at least one prescription opioid in the past year. Participants were shown 13 images and names of prescription pain relievers and opioids (e.g. Codeine, Hydrocodone, or Hydromorphone) and asked to indicate (yes/no) whether they had used each medication for nonmedical purposes within the past year. Medication names were provided alongside the images, such that pictures of brand name medications were labeled with the registered brand name (e.g. OxyContin® or Percocet®), and pictures of generic medications were labeled with the name of the medication (e.g. morphine, codeine). Participants who endorsed nonmedical use of at least one opioid were considered positive for past year nonmedical opioid use (dichotomized as 0 = negative for past year non-medical opioid use; 1 = positive for past year nonmedical opioid use). This assessment and conceptualization of non-medical prescription is consistent with prior work (Zale et al., 2015).

## Procedure

According to eligibility criteria, participants were directed to the study participation link and if interested, they completed the online anonymous survey. Prior to completing the survey, participants provided informed consent. The survey took approximately 30 min to complete, and participants were compensated with credit through their Qualtrics account to commensurate their participation. Each participant was given the option to choose their preferred form of compensation based on their credit, however, the total amount for completing the survey remained the same ($8.50). In terms of data quality, Qualtrics estimated known population values within a 10% discrepancy rate and has shown to outperform other survey method platforms (Heen et al., 2014). To further ensure the quality of data, IP addresses were obtained to prohibit duplicate responses, responses were omitted based on constant responding (long-string assessment), completion time (less than 10 min), and nonsensical responses. Data analyses were restricted to those with complete data on the studied variables. The study protocol was approved by the Institutional Review Board at the institution supporting this research.

## Data analytic strategy

Data analyses were completed using SPSS version 25. First, differences between dual ($n$ = 402; 75.7%) and exclusive e-cigarette users ($n$ = 129; 24.3%) on demographics and e-cigarette use history were examined using a $t$-tests for continuous variables and chi-square tests for categorical variables. Second, independent samples $t$-tests and chi-squares tests were conducted to examine differences in substance use constructs (i.e. PSECDI total score, AUDIT, cannabis use and past year nonmedical prescription opioid use) across dual and exclusive e-cigarette users.

A Bonferroni correction was employed to decrease the probability of Type I error. Based on this correction, the level of statistical significance has been adjusted to .013 (i.e..05/4) (Weisstein, 2004). Informed by extant work (Du et al., 2019; Rhoades et al., 2019), planned post-hoc analyses were conducted to assess differences between dual combustible cigarette and exclusive e-cigarette use on item-level data of the PSECDI. A bivariate logistic regression analysis was performed to investigate presence of factors that may contribute to

the likelihood of dual use status. Consistent with the overall analytic analysis approach, continuous items (items 1 and 2) were evaluated using *t*-tests and categorical items (items 3, 4, 5, 6, 7, 8, 9, and 10) were evaluated with chi-square tests. Effect sizes were estimated using Cohen's *d* (interpretation: .20 = small; .50 = medium; .80 = large) (Cohen, 1988), for *t*-tests and Cramer's *V* for chi-square tests. Interpretation for Cramer's *V* varied as a function of degrees of freedom but followed recommendations by Cohen (Cohen, 1988).

## Results

Most participants were White/Caucasian (76.5%), with 16.8% identifying as Black/African American, 3.0% Asian, 1.3% Native American/Alaska Native, 2.1% Other, and 0.4% Hawaiian. In terms of education, 24.9% reported attaining a high school diploma, 23.2% reported "some college", 12.4% reported receiving an associate degree, and of the remaining sample, 36.5% specified completing their bachelor's degree or higher. The median income bracket fell within the range of $35,000 to $49,999. A medium level of e-cigarette dependence was observed in the sample ($M = 8.9$, $SD = 4.1$). Approximately 75.7% indicated dual current combustible cigarette use. Among dual users, participants indicated smoking 13.13 ($SD = 17.2$) cigarettes per day on average and being a daily smoker for an average of 16.0 ($SD = 10.6$) years.

Dual and exclusive e-cigarette users did not differ on sex ($X^2[1] = 3.25$, $p = .07$), age ($t[527] = .28$, $p = .78$), race ($X^2[5] = 4.69$, $p = .45$), education level ($t[529] = -1.26$, $p = .21$), or income ($t[529] = -.34$, $p = .73$). Dual and exclusive e-cigarette users did not differ on the number of months they have used e-cigarettes ($t[527] = 1.82$, $p = .07$), age at which they started daily e-cigarette use ($t[526] = .65$, $p = .52$), or endorsement of a past serious attempt for quitting e-cigarettes ($X^2[1] = .35$, $p = .55$).

Regarding e-cigarette dependence, dual combustible/e-cigarette users had significantly higher levels of dependence than exclusive e-cigarette users ($t[529] = -5.60$, $p < .001$).

For problematic alcohol use, dual combustible/e-cigarette users endorsed a significantly higher total AUDIT score than exclusive e-cigarette users ($t[529] = -5.85$, $p < .001$).

Dual and exclusive e-cigarette users did not differ on reported history of cannabis use ($X^2[1] = 1.96$, $p = .16$). Restricted to those who reported current or past cannabis use, dual users reported significantly higher cannabis use in the last 30 days ($t[306] = -5.60$, $p < .001$).

Finally, dual users were significantly more likely to endorse nonmedical prescription opioid use in the last year than exclusive e-cigarette users ($X^2[1] = 6.50$, $p = .01$). Significant effects were .11 to .64 in magnitude. See Table 1.

To evaluate the predictive power of e-cigarette dependence, alcohol use, cannabis use, and non-prescription opioid use on the likelihood of dual use status, a logistical regression was conducted. A bivariate logistic regression analysis indicated that e-cigarette use dependence levels (OR = .91, 95% CI = .86 − .96, $p = .001$) and alcohol use (OR = .95, 95% CI = .93 −.98, $p = .001$) were factors that statistically increased the risk for dual use status. Contrary to prediction, neither a history of cannabis use (OR = .98, 95% CI = 88 − 1.1, $p = .78$) or

use of non-prescription opioids (OR = .91, 95% CI = .60 − 1.39, $p = .67$) were statistically significant predictors of dual use status.

Post-hoc analyses of specificity tests were conducted to examine differences in dual combustible/e-cigarette and exclusive e-cigarette users across item-level indicators of e-cigarette dependence and revealed that the two groups did not differ on their frequency of daily e-cigarette use ($t[529] = -1.85$, $p = .07$) or latency to first e-cigarette use of the day ($t[529] = .86$, $p = .39$). Relative to exclusive users, dual users were more likely to awaken at night to use their e-cigarette ($X^2[1] = 24.75$, $p < .001$) and awoke more frequently ($X^2[2] = 22.18$, $p < .001$). Dual users also were more likely to attribute their e-cigarette use to finding it difficult to quit e-cigarettes ($X^2[1] = 18.39$, $p < .001$). Findings indicated that dual users were more likely to endorse e-cigarette craving ($X^2[1] = 35.01$, $p < .001$) and reported stronger cravings ($X^2[2] = 36.83$, $p < .001$) than exclusive e-cigarette users. Dual users were more likely to report difficulty refraining from using an e-cigarette in places where people are not supposed to use the product ($X^2[1] = 12.58$, $p < .001$). Regarding irritability and withdrawal, dual users were significantly more likely than exclusive e-cigarettes users to endorse irritability related to e-cigarette withdrawal ($X^2[1] = 22.34$, $p < .001$) as well as feeling nervous, restless, or anxious related to e-cigarette withdrawal ($X^2[1] = 23.73$, $p < .001$). All significant effects ranged from .15 to .26 in magnitude. See Table 1.

## Discussion

The primary aim of the current work was to investigate differences in substance use dependence and behavior across dual and exclusive cigarette users. Results were generally consistent with expectation. Specifically, dual users endorsed higher levels of e-cigarette dependence, higher levels of problematic alcohol use, greater cannabis use (among ever users) in the past month, and higher likelihood of nonmedical prescription opioid use. Moreover, statistically significant differences across indicators of e-cigarette dependence suggest that dual users may experience the negative consequences of e-cigarette use more severely than exclusive e-cigarette users. These promising findings should be interpreted in the context of the cross-sectional nature of the present study and do not provide evidence of causality. Thus, the present preliminary data provide initial evidence that adult dual and exclusive e-cigarette uses may experience unique substance dependence and behavior and support continued scientific inquiry into the directional association between these variables.

Consistent with extant work among adolescent and young adult e-cigarette users (Case et al., 2018; Liu et al., 2017; Morean et al., 2018; Sung et al., 2018), data identified dual e-cigarette and combustible cigarette using adults as a potentially vulnerable population susceptible to greater e-cigarette addiction and substance use. Notably, the medium effect sizes underscore the potential clinical significance of the present findings. The question of why dual users may be more vulnerable to e-cigarette dependence and co-use of other substance use deserves thoughtful consideration. One possibility is that this may constitute a group at increased risk of experiencing affective vulnerabilities. Indeed, some emerging data has found that dual users experience greater affective vulnerability relative to exclusive e-cigarette users (Leventhal et al., 2016; Shan et al., 2020; Weinberger et al., 2020). It may be that dual users are more likely to engage in polysubstance use (including alcohol,

cannabis, and opioid use) and more severe e-cigarette use for mood regulation, as negative affect reduction is a leading motive for substance use and is consistently related to more severe use (Baker et al., 2004). Moreover, binary logistic analysis indicated that e-cigarette dependence and alcohol use were factors that contributed to dual use status. These findings suggest that those with a history of problematic alcohol use or those that endorse greater e-cigarettes dependence may be at greater risk for future dual use status. The current work only helps to establish an initial link between dual use and substance use outcomes among an adult sample. Future research is now needed to explicate the mechanisms governing the greater e-cigarette dependence and co-use of other substances among adult dual users.

To provide a more in depth understanding of the variations between dual and exclusive e-cigarette users, the items on the PSECDI were examined individually. Results showcased differences among specific dependence symptoms across groups; these data may help inform further e-cigarette cessation work across dual and exclusive users. Item-level inspection of e-cigarette dependence showed a varying scope of differences between dual and exclusive e-cigarette users. As with past work (Du et al., 2019), frequency of daily e-cigarette use and latency of the first e-cigarette use of the day did not differ between exclusive e-cigarette users and dual users. Contrary to Du et al. (Du et al., 2019), however, our findings suggest that dual use may be related to increased e-cigarette craving, greater difficulty refraining from use, and increased e-cigarette withdrawal. The discrepancy between the current and prior work may be due to the nature of group classification (i.e. poly users/dual users) and/or sample characteristics (i.e. sex ratio, age). These data support further exploration of dual users as a vulnerable nicotine use group.

At the most basic level of analysis, the present data highlight the relevance of assessing the differences in substance use behavior across exclusive and dual users. We found that adult dual users can be characterized as having higher nicotine dependence and possess significant differentiating characteristics among multiple types of substance use. Thus, dual use may be one characteristic to consider when investigating poly-substance use, assessing vulnerability factors of poly-substance use, and developing integrated treatment plans for addiction. As adult dual users may constitute a vulnerable group susceptible to other substance use, smoking cessation interventions for dual users may benefit from integrating a module on methods to abstain from other substances, as well as psychoeducation on the comorbidity between nicotine use and other substance use (Boland et al., 2018; Das et al., 2016; Kalkhoran & Glantz, 2016; Rigotti et al., 2018).

Several study limitations warrant mention. First, the cross-sectional study design does not allow for conclusions to be made about causality between the studied variables. Future studies should implement longitudinal designs to examine how substance use and e-cigarette dependence among groups behave over time. Second, the primary method of data collection was self-report measures. Although most of the past work investigating dual users and e-cigarette dependence have utilized self-report measures (Chou et al., 2017; Hefner et al., 2019; Mirbolouk et al., 2018), future work would benefit from incorporating other assessment modalities (e.g. biologic indicators of use, topography methods) to offer a complimentary lens on the nature of substance use. Third, the study may not be representative of racial/ethnic minorities because the current sample was primarily

Caucasian/White. Most of the sample also consisted of dual users. As such, future studies could investigate the present hypotheses among more balanced sized groups. Additionally, participant recruitment and complete data collection were exclusively online. Therefore, persons without internet access were, by definition, excluded. Although those without internet access make up a small minority of the general population (Roser et al., 2015), and online data collection is a valid and tested methodological approach (Evans & Mathur, 2018; Wright, 2006), future research could nonetheless employ alternative recruitment methods (e.g. community-based sampling or clinical referrals). Fourth, a class analysis of clusters of individuals who use many different substances and e-cigarettes could usefully inform current work. The current study was not idea for such a test given the sample size and a priori aims of the investigation. Sixth, the current work did not collect data on reasons for e-cigarette use uptake. Past research reports adult e-cigarette users initiate use as a means for combustible cigarette use cessation (Berg et al., 2014). To capture a more comprehensive overview of e-cigarette users, future work would likely benefit from assessing reasons for use among adults.

## Conclusions

Overall, the current investigation suggests that dual users report significantly more problematic alcohol use, greater cannabis use, and higher nonmedical prescription opioid use, as well as higher e-cigarette dependence when compared to exclusive e-cigarette users. Moreover, the likelihood of dual use status is statistically and significantly associated with the use of alcohol and levels of e-cigarette dependence. This work is in line with the perspective that dual users are a vulnerable group on several markers of e-cigarette and substance co-use. Future research is needed to understand the reasons driving greater substance use among dual users.

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**Table 1.**

Significant differences between dual users and exclusive e-cigarettes and effect sizes.

| | Dual users (*n* = 402) | Exclusive e-cigarette users (*n* = 129) | | | |
|---|---|---|---|---|---|
| | M (SD) or % [n] | M (SD) or % [n] | t or $X^2$ | p value | d or Cramer's V (df) |
| PSECDI | 9.43 (3.82) | 7.17 (4.46) | −5.60 | <.001 | .54 |
| AUDIT | 14.24 (11.29) | 7.99 (7.87) | −5.85 | <.001 | .64 |
| Currently or ever cannabis use (% ever) | 59.7% [240] | 52.7% [68] | 1.96 | .16 | .06 (1) |
| Freq cannabis use (among users) | 2.88 (3.32) | 1.72 (2.78) | −5.60 | <.001 | .38 |
| Nonmedical prescription opioid use PSECDI Item Level Data | 42.0% [169] | 29.5% [38] | 6.50 | .01 | .11 (1) |
| 1. Frequency of daily e-cigarette use | 1.40 (1.49) | 1.12 (1.50) | −1.85 | .07 | .19 |
| 2. Latency of first e-cigarette of the day | 3.19 (1.50) | 3.33 (1.79) | .86 | .39 | .08 |
| 3. Waking e-cigarette | 47.3% [190] | 22.5% [29] | 24.75 | <.001 | .22 (1) |
| 4. Nights of waking e-cigarette use frequency | 0–1 times, 63.4% [255] 2–3 times, 27.1% [109] >4 times, 9.5% [38] | 0–1 times, 85.3% [110] 2–3 times, 12.4% [16] >4 times, 2.3% [3] | 22.18 | <.001 | .20 (2) |
| 5. E-cigarette quit difficulty | 65.4% [263] | 44.2% [57] | 18.39 | <.001 | .19 (1) |
| 6. Presence of e-cigarette cravings | 68.7% [276] | 39.5% [51] | 35.01 | <.001 | .26 (1) |
| 7. Strength of e-cigarette cravings | None/Slight, 27.6% [111] Moderate/Strong, 54.2% [218] Very Strong/ Extremely Strong, 18.2% [73] | None/Slight, 54.3% [70] Moderate/Strong, 41.9% [54] Very Strong/ Extremely Strong, 3.9% [5] | 36.83 | <.001 | .26 (2) |
| 8. E-cigarette refrain Difficulty | 51.2% [206] | 33.3% [43] | 12.58 | <.001 | .15 (1) |
| 9. Irritability related to e-cigarette withdrawal | 56.5% [227] | 32.6% [42] | 22.34 | <.001 | .21 (1) |
| 10. Nervousness related to e-cigarette withdrawal | 58.0% [233] | 33.3% [43] | 23.73 | <.001 | .21 (1) |

Note. *N* = 531; Cohen's d effect size range: <.20 = small effect, .20−.80 = medium effect, >.80 = large effect (Cohen, 1988); Cramer's V effect size (df = 1): <.10 = small effect, .10−.50 = medium effect, >.50 = large effect (Cohen, 1988); Cramer's effect size (df = 2): <.07 = small effect, .07−.35 = medium effect, >.35 = large effect (Cohen, 1988); PSECDI = Penn State Electronic Cigarette Dependence Index total score (Foulds et al., 2015); AUDIT = Alcohol Use Disorders Identification Test total score (Saunders et al., 1993); Nonmedical prescription opioid use = positive endorsement of non-medical use of at least one prescription opioid in the past year.(Butler et al., 2007) Percentage and n represent affirmative endorsement of item.