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Patterns and Frequency of Current e-Cigarette Use in United States Adults

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Abstract

Background: In the United States (US), electronic cigarette (e-cigarette) use prevalence has increased since 2010. Few studies, however, have addressed frequency of use at the population-level. This study examines patterns and correlates of e-cigarette use frequency in a novel national sample.

Methods: Data were from 36,277 US adults interviewed between 2012 and 2013 for the National Epidemiologic Survey on Alcohol and Related Conditions-III (NESARC-III). Sociodemographic characteristics, other tobacco/drug use, and psychiatric disorders were compared by e-cigarette use status (i.e. current [past-month], past, never) and e-cigarette use frequency (i.e. infrequent [≤ 3 days/month], moderate [1–6 days/week], daily). Multinomial logistic regression models compared correlates of e-cigarette use status and e-cigarette use frequency.

Results: Current e-cigarette use was low in adults (1.4%) and past e-cigarette use was 3.9%. Among current e-cigarette users, 38.1% were infrequent users, 32.9% were moderate users, and 29.0% were daily users. Compared to infrequent e-cigarette users, daily users were more likely to be male and older, but less likely to be current cigarette smokers and alcohol drinkers (p 's $< .05$). Compared to daily e-cigarette users, moderate users were more likely be female, current cigarette smokers, and fall into the 25–34 age group (p 's $< .05$). Moderate and daily e-cigarette users had higher prevalence of current extra-medical opioid use than infrequent users (p 's $< .05$).

Conclusions/Importance: E-cigarette users were most often infrequent users versus moderate or daily users. Compared to infrequent and moderate users, daily e-cigarette users were less likely to be current alcohol drinkers or cigarette smokers. Novel findings highlight a correlation between more frequent e-cigarette and opioid use.

Keywords

Electronic cigarettes; frequency; United States; epidemiology; opioids

Introduction

Since 2010, e-cigarette use has increased in the United States (US; CDCMMWR, 2017; Schoenborn & Gindi, 2015). The most recent US epidemiological surveys show that current adult e-cigarette use estimates range from 1.4% to 6.8% (Chou et al., 2017; Coleman et al., 2017; Delnevo et al., 2016; Kasza et al., 2017; McMillen, Gottlieb, Shaefer, Winickoff, & Klein, 2015; Phillips, 2017). A handful of studies have addressed frequency of e-cigarette use (Amato, Boyle, & Levy, 2016; Sharapova, Singh, Agaku, Kennedy, & King, 2017), though few have done so in a large, national sample (Coleman et al., 2017). These studies show that many adults who start using e-cigarettes, do not persist in their use (Amato et al., 2016). For example, about 25% of individuals who used e-cigarettes infrequently in the past month, still used one year later. This, however, varied depending on frequency of e-cigarette use; more than 75% of daily e-cigarette users subsequently used one year later (Amato, Boyle, & Levy, 2017; Coleman et al., 2018).

Several correlates of e-cigarette use may contribute to their prevalence in the US. Research suggests that most current e-cigarette users are not using daily (Zhu et al., 2013) and are either current or past cigarette smokers (Delnevo et al., 2016; King, Patel, Nguyen, & Dube, 2015; McMillen et al., 2015; Schoenborn & Gindi, 2015). This may be because e-cigarettes have been promoted for harm reduction or smoking cessation and cigarette smokers have experimented with them as a cessation aid (Coleman et al., 2017). Indeed, many daily e-cigarette users report using them to reduce or quit smoking (Biener & Hargraves, 2015; Brose, Hitchman, Brown, West, & McNeill, 2015).

Patterns of e-cigarette use not only differ by cigarette smoking history, but also other individual characteristics, including race/ethnicity (Chou et al., 2017; Delnevo et al., 2016), age (Agaku et al., 2014; Chou et al., 2017; Coleman et al., 2017; Delnevo et al., 2016; McMillen et al., 2015), education (Chou et al., 2017; McMillen et al., 2015), psychiatric disorders, and other tobacco/drug use (Chou et al., 2017; Miech, O'Malley, Johnston, & Patrick, 2016; Sharapova et al., 2017). Individuals with psychiatric disorders, such as anxiety and depression, have been found to be more likely to be current e-cigarette users or have tried e-cigarettes than those without these diagnoses (Chou et al., 2017; Cummins, Zhu, Tedeschi, Gamst, & Myers, 2014). For alcohol, problematic drinking has been associated with e-cigarette use (Cohn et al., 2015), with social e-cigarette users drinking more alcohol than regular e-cigarette users (Hershberger, Karyadi, VanderVeen, & Cyders, 2016). In young people, e-cigarette use has been associated with alcohol, cannabis, and extra-medical prescription use (i.e. use outside the boundaries of a prescriber, see Parker & Anthony, 2015; Miech et al., 2016), but most research has focused on the relationship between drugs and traditional cigarettes. For example, past-year smokers were at least three times more likely than nonsmokers to use opioids extra-medically (Zale et al., 2015). In addition, the prevalence of extra-medical opioid use has increased among current smokers in recent years (Moeller et al., 2018). This pattern may be comparable for e-cigarettes due to reinforcement pathways between tobacco use and pain as well as the pharmacological interaction between nicotine and opioids (Ditre, Brandon, Zale, & Meagher, 2011). One national study reported higher prevalence of past-year alcohol and drug use among current adult e-cigarette users, but did not address differences in use by e-cigarette frequency (Conway et al., 2017).

Indeed, some of these characteristics vary by frequency of e-cigarette use. Daily e-cigarette use has been found to be lowest among younger adults (Coleman et al., 2017; Sharapova et al., 2017). Infrequent e-cigarette use is prevalent in current cigarette smokers (Amato et al., 2016; Coleman et al., 2017), users of other combusted products (Coleman et al., 2017), and users of other tobacco products (Sharapova et al., 2017). Less frequent e-cigarette users also have higher problematic alcohol use than more frequent users (Hershberger et al., 2016). The relationship between pain and cigarette smoking suggests a positive feedback loop between the two (Ditre et al., 2011), which may indicate a correlation between opioid use and more frequent e-cigarette use.

Until recently, population-level surveys that included measures on e-cigarettes asked only about ever and current use (King et al., 2015; McMillen et al., 2015; Pearson et al., 2017). However, the National Epidemiologic Survey on Alcohol and Related Conditions-III (NESARC-III; Grant et al., 2014) asked a detailed battery of items on e-cigarette use, including frequency of use. This study evaluates patterns and correlates of past and current e-cigarette use, as well as e-cigarette use frequency among current e-cigarette users in this nationally representative dataset. We hypothesized that there would be a positive relationship between e-cigarette use frequency and current alcohol, cigarette, and extra-medical opioid use.

Methods

Data source & sample

Data came from the NESARC-III, a national cross-sectional epidemiological survey, which includes the US non-institutionalized civilian population 18 years or older. Multistage probability sampling was employed, with oversampling of Hispanics, Blacks, and Asians. Data were collected from April 2012 through June 2013. The effective sample size for the present investigation was 36,277 adults. Detailed methods have been published elsewhere (Grant et al., 2014).

Measures

The sample was divided into three mutually exclusive e-cigarette use status groups: current, past, and never e-cigarette users. Groups were defined by the survey question, “When was the most recent time you used e-cigarettes/e-liquid?” Current e-cigarette users all had used an e-cigarette in the past month (e.g. 30 days). Past e-cigarette users had ever used e-cigarettes in their lifetime, but were not current e-cigarette users. Never e-cigarette users were identified as respondents who never used e-cigarettes in their lifetime.

Current e-cigarette users were further classified by their frequency of e-cigarette use defined by the survey question: “About how often did you usually use e-cigarettes/e-liquid in the past year/year right before you stopped?” Users chose from prespecified categories: every day, 5–6 days per week, 3–4 days per week, 1–2 days per week; 2–3 days a month; and once a month or less. To be consistent with Coleman et al. (2017), categories were collapsed so that infrequent users used e-cigarette 1–3 days/month, moderate users used 1–6 days/week, and daily users used every day (Parker, Pearson, & Villanti, 2019).

Sex (male/female), race/ethnicity (non-Hispanic white, non-Hispanic black, or African American, non-Hispanic other (i.e. Asian, American-Indian, or Alaskan Native, other, multirace), and Hispanic), age (18–24, 25–34, 35–44, 45–54, 55+), and education (less than high-school, high-school diploma, some college, Bachelor's degree or more) were included as sociodemographic characteristics. Other current tobacco (i.e. cigarette, cigar, pipe, snuff), alcohol, cannabis, and extra-medical opioid use in the past month were assessed by “When was the most recent time you used [product/drug]?” Extra-medical opioid use was defined as use either without a doctor's prescription; in greater amounts, more often, for longer, or for a reason other than prescribed (Parker & Anthony, 2015). NESARC-III uses the Alcohol Use Disorder and Associated Disabilities Interview Schedule-DSM-5 Version (AUDADIS-5) instrument for non-clinician interviewers. Anxiety was comprised of generalized anxiety disorder, specific phobia, social anxiety disorder, panic disorder, and agoraphobia. Depression included major depression, mania, and dysthymia (Hasin et al., 2015).

Analysis

Weighted percentages of e-cigarette use status and frequency of e-cigarette use were produced by sociodemographic characteristics, other tobacco/drug use, and psychiatric disorders. Then, multinomial logistic regression models produced risk rate ratio (RRR) estimates for e-cigarette use status and for frequency of use in current e-cigarette users while controlling for all correlates. Data were analyzed using Stata, version 14 (Stata Corp, 2015), accounting for NESARC-III's complex sampling design using survey weights.

Results

Current e-cigarette use was low in adults (1.4%, 95% CI: 1.3%, 1.6%) and past e-cigarette use was slightly higher (3.9%, 95% CI: 3.7%, 4.2%). Current and past e-cigarette use was highest in non-Hispanic whites, those aged 25–34, current cigarette smokers, and current alcohol drinkers (Table 1). In logistic regression models, current and past e-cigarette users were similar across sociodemographic and other characteristics although past e-cigarette users were significantly more likely to be male (ARRR = 1.4; 95% CI: 1.1, 1.7; data not shown in table). Compared to never e-cigarette users, current, and past e-cigarette users were more likely to be non-Hispanic whites, younger, and current cigarette smokers. They also had higher prevalence of current extra-medical opioid use and were more likely to have completed some college (p 's < .05; Table 1).

Among current e-cigarette users, 38.1% were infrequent users, 32.9% were moderate users, and 29.0% were daily users (Table 2). The only difference in characteristics between infrequent and moderate e-cigarette users was that moderate users were more likely to use opioids extra-medically (ARRR = 3.8; 95% CI: 1.4, 10.6). Compared to infrequent e-cigarette users, daily e-cigarette users were more likely to be male (ARRR = 4.6; 95% CI: 2.3, 9.1), but less likely to be in the youngest age groups compared to being 55+ (i.e. older), current cigarette smokers (ARRR = 0.3; 95% CI: 0.1, 0.6), and current alcohol drinkers (ARRR = 0.4; 95% CI: 0.2, 0.7) (Table 2). Compared to daily e-cigarette users, moderate e-cigarette users were more likely be female (ARRR = 2.8; 95% CI: 1.5, 5.3), current cigarette smokers (ARRR = 4.5; 95% CI: 2.0, 9.9), and fall into the 25–34 age group (ARRR = 3.7;

95% CI: 1.4, 9.8, data not shown in table). Both moderate and daily e-cigarette users had a higher prevalence of current extra-medical opioid use compared to infrequent users (Table 2).

Discussion

Consistent with another national sample (Coleman et al., 2017), this study highlights that approximately 40% of current e-cigarette users use infrequently. Novel findings include that current alcohol drinking was more prevalent among infrequent e-cigarette users and that more frequent e-cigarette use was correlated with current extra-medical opioid use. While alcohol use disorder has been associated with past-year e-cigarette use (Chou et al., 2017), this study is the first to explore concurrent or simultaneous alcohol drinking in more recent adult e-cigarette users while considering frequency of use. For young people, e-cigarette access has been related to alcohol drinking behaviors (e.g. Hughes et al., 2015). One study found that alcohol use predicted trying e-cigarettes and future intentions for use, but alcohol did not affect transitioning to regular e-cigarette use (Lee, Lin, Seo, & Lohrmann, 2017). At the population-level, recent alcohol users may be experimenting or trying e-cigarette use more socially, which is consistent with our findings (Hershberger et al., 2016).

Prior epidemiologic work has shown that cigarette smoking is associated with extra-medical opioid use (Conway et al., 2017). In our sample, current extra-medical opioid use was more prevalent among cigarette smokers than nonsmokers (Parker, 2019). Studies to date have found a relationship between e-cigarette and opioid use among adolescents (Miech et al., 2016) and an association between adolescent frequent/daily e-cigarette use and extra-medical prescription use (McCabe, West, Veliz, & Boyd, 2017). For adults, studies on extra-medical opioid use and e-cigarette use are sparse. Research has found the proportion of opioid dependent smokers who used e-cigarettes in the past month as much higher than general population surveys (Stein et al., 2015). Our study extends these findings highlighting a relationship between moderate or daily e-cigarette use and current extra-medical opioid use in adults while adjusting for cigarette smoking.

The 2012–2013 prevalence of current and past e-cigarette use were 1.4% and 3.9% are similar to other US surveys conducted during the same timeframe (Agaku et al., 2014; King et al., 2015; Zhu et al., 2013). The present study found that current e-cigarette use was more prevalent among non-Hispanic whites, younger ages, and current cigarette smokers compared to never e-cigarette users, consistent with other recent e-cigarette surveillance studies (Chou et al., 2017; Delnevo et al., 2016).

With respect to frequency of use, moderate e-cigarette users were more likely to be current cigarette smokers than daily e-cigarette users, and daily e-cigarette users were less likely to be current smokers compared to less frequent users. In the literature, infrequent e-cigarette use is more often associated with experimentation, whereas daily/more intensive e-cigarette use has been associated with the cessation attempts, quitting smoking, or the intent to quit (Biener & Hargraves, 2015; Brose et al., 2015; Coleman et al., 2017). It may be that daily e-cigarette users are substituting e-cigarette use for their combustible use, while less intensive e-cigarette users use multiple tobacco products (i.e. e-cigarettes and cigarettes).

While findings support that past-month e-cigarette use is less likely in older adults versus younger age groups (Agaku et al., 2014; Chou et al., 2017; Coleman et al., 2017; Delnevo et al., 2016; McMillen et al., 2015), this relationship disappears when looking at different e-cigarette use frequency groups (Delnevo et al., 2016). In daily e-cigarette users, e-cigarette use was less likely in the youngest age groups and more likely in the older age groups. For young adults, this indicates more common experimental use (Delnevo et al., 2016; Villanti et al., 2017). Daily use among older adults may reflect more routine use for smoking cessation (Sharapova et al., 2017). Sex differences reported for e-cigarette use (Agaku et al., 2014; Chou et al., 2017) were apparent when we compared past users to current and never users, and males were more likely to be daily e-cigarette users than infrequent users.

This study has several strengths and limitations. We present estimates of current, past, and never e-cigarette use, as well as frequency of e-cigarette use in a novel dataset. We could not produce estimates of e-cigarette use with more detail on cigarette use (e.g. quit status, former smoker) as survey items did not address smoking cessation, and there were no former smokers in our sample of e-cigarette users. In addition, data from the NESARC-III survey was collected in 2012–2013 and there has continued to be evolution in the e-cigarette market. Furthermore, temporal conclusions about the direction of e-cigarette use and use of cigarettes or other drugs could not be made due to the cross-sectional nature of the data. Longitudinal studies are necessary to determine the sequence and duration of e-cigarette use in relationship to the use of tobacco products and other substances.

Current e-cigarette use widely varies across frequency of use, in population subgroups, and by co-use with other drugs, even after adjusting for smoking status. These findings highlight the need for continued research to understand the intersection of e-cigarette use with other drug use and consideration of at-risk populations in designing interventions and policies to maximize the benefit and minimize the harms of e-cigarette use at the population level.

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References

- Agaku IT, King BA, Husten CG, Bunnell R, Ambrose BK, Hu SS, ... Day HR (2014). Tobacco product use among adults — United States, 2012–2013. *MMWR. Morbidity and Mortality Weekly Report*, 63(25), 542–547. [PubMed: 24964880]
- Amato MS, Boyle RG, & Levy D (2016). How to define e-cigarette prevalence? Finding clues in the use frequency distribution. *Tobacco Control*, 25(E1), e24–e29. 10.1136/tobaccocontrol-2015-052236 [PubMed: 26085124]
- Amato MS, Boyle RG, & Levy D (2017). E-cigarette use 1 year later in a population-based prospective cohort. *Tobacco Control*, 26(e2), e92–e96. 10.1136/tobacco-control-2016-053177 [PubMed: 27807298]

- Biener L, & Hargraves JL (2015). A longitudinal study of electronic cigarette use among a population-based sample of adult smokers: Association with smoking cessation and motivation to quit. *Nicotine & Tobacco Research*, 17(2), 127–133. 10.1093/ntr/ntu200 [PubMed: 25301815]
- Brose LS, Hitchman SC, Brown J, West R, & McNeill A (2015). Is the use of electronic cigarettes while smoking associated with smoking cessation attempts, cessation and reduced cigarette consumption? A survey with a 1-year follow-up. *Addiction (Abingdon, England)*, 110(7), 1160–1168. 10.1111/add.12917
- CDCMMWR. (2017). QuickStats: Percentage of adults who ever used an e-cigarette and percentage who currently use e-cigarettes, by age group — National Health Interview Survey United States, 2016. *MMWR. Morbidity and Mortality Weekly Report*, 66(33), 892 10.15585/mmwr.mm6633a6 [PubMed: 28837550]
- Chou SP, Saha TD, Zhang H, Ruan WJ, Huang B, Grant BF, ... Compton W (2017). Prevalence, correlates, comorbidity and treatment of electronic nicotine delivery system use in the United States. *Drug and Alcohol Dependence*, 178(Suppl C), 296–301. 10.1016/j.drugalcdep.2017.05.026 [PubMed: 28686988]
- Cohn A, Villanti A, Richardson A, Rath JM, Williams V, Stanton C, & Mermelstein R (2015). The association between alcohol, marijuana use, and new and emerging tobacco products in a young adult population. *Addictive Behaviors*, 48, 79–88. 10.1016/j.addbeh.2015.02.005 [PubMed: 26042613]
- Coleman BN, Rostron B, Johnson SE, Ambrose BK, Pearson J, Stanton CA, ... Hyland A (2017). Electronic cigarette use among US adults in the Population Assessment of Tobacco and Health (PATH) Study, 2013–2014. *Tobacco Control*, 26, e117–e126. 10.1136/tobaccocontrol-2016-053462 [PubMed: 28624763]
- Coleman BN, Rostron B, Johnson SE, Persoskie A, Pearson J, Stanton C, ... Hyland A (2019). Transitions in electronic cigarette use among adults in the Population Assessment of Tobacco and Health (PATH) Study, Waves 1 and 2 (2013–2015). *Tobacco Control*, 28, 50–59. 10.1136/tobaccocontrol-2017-054174 [PubMed: 29695458]
- Conway KP, Green VR, Kasza KA, Silveira ML, Borek N, Kimmel HL, ... Compton WM (2017). Co-occurrence of tobacco product use, substance use, and mental health problems among adults: Findings from Wave 1 (2013–2014) of the Population Assessment of Tobacco and Health (PATH) Study. *Drug and Alcohol Dependence*, 177, 104–111. 10.1016/j.drugalcdep.2017.03.032 [PubMed: 28582698]
- Cummins SE, Zhu S-H, Tedeschi GJ, Gamst AC, & Myers MG (2014). Use of e-cigarettes by individuals with mental health conditions. *Tobacco Control*, 23(Suppl 3), iii48–iii53. 10.1136/tobaccocontrol-2013-051511 [PubMed: 24824516]
- Delnevo CD, Giovenco DP, Steinberg MB, Villanti AC, Pearson JL, Niaura RS, & Abrams DB (2016). Patterns of electronic cigarette use among adults in the United States. *Nicotine & Tobacco Research*, 18(5), 715–719. 10.1093/ntr/ntv237 [PubMed: 26525063]
- Ditre JW, Brandon TH, Zale EL, & Meagher MM (2011). Pain, nicotine, and smoking: Research findings and mechanistic considerations. *Psychological Bulletin*, 137(6), 1065–1093. 10.1037/a0025544 [PubMed: 21967450]
- Grant BF, Chu A, Sigman R, Amsbary M, Kali J, Sugawara Y, ... Goldstein R (2014). Source and accuracy statement: National epidemiologic survey on alcohol and related conditions-III (NESARC-III) Retrieved from National Institute on Alcohol Abuse and Alcoholism website: https://www.niaaa.nih.gov/sites/default/files/NESARC_Final_Report_FINAL_1_8_15.pdf
- Hasin DS, Shmulewitz D, Stohl M, Greenstein E, Aivadyan C, Morita K, ... Grant BF (2015). Procedural validity of the AUDADIS-5 depression, anxiety and post-traumatic stress disorder modules: sub-stance abusers and others in the general population. *Drug and Alcohol Dependence*, 152, 246–256. 10.1016/j.drugalcdep.2015.03.027 [PubMed: 25939727]
- Hershberger AR, Karyadi KA, VanderVeen JD, & Cyders MA (2016). Combined expectancies of alcohol and E-cigarette use relate to higher alcohol use. *Addictive Behaviors*, 52, 13–21. 10.1016/j.addbeh.2015.08.005 [PubMed: 26334561]
- Hughes K, Bellis MA, Hardcastle KA, McHale P, Bennett A, Ireland R, & Pike K (2015). Associations between e-cigarette access and smoking and drinking behaviours in teenagers. *BMC Public Health*, 15(1), 244 10.1186/s12889-015-1618-4 [PubMed: 25886064]

- Kasza KA, Ambrose BK, Conway KP, Borek N, Taylor K, Goniewicz ML, ... Hyland AJ (2017). Tobacco-product use by adults and youths in the United States in 2013 and 2014. *New England Journal of Medicine*, 376(4), 342–353. 10.1056/NEJMsa1607538 [PubMed: 28121512]
- King BA, Patel R, Nguyen KH, & Dube SR (2015). Trends in awareness and use of electronic cigarettes among US adults, 2010–2013. *Nicotine & Tobacco Research*, 17(2), 219–227. 10.1093/ntr/ntu191 [PubMed: 25239961]
- Lee H-Y, Lin H-C, Seo D-C, & Lohrmann DK (2017). Determinants associated with E-cigarette adoption and use intention among college students. *Addictive Behaviors*, 65, 102–110. 10.1016/j.addbeh.2016.10.023 [PubMed: 27816034]
- McCabe SE, West BT, Veliz P, & Boyd CJ (2017). E-cigarette use, cigarette smoking, dual use, and problem behaviors among U.S. adolescents: Results from a national survey. *Journal of Adolescent Health*, 61(2), 155–162. 10.1016/j.jadohealth.2017.02.004 [PubMed: 28391965]
- McMillen RC, Gottlieb MA, Shaefer RMW, Winickoff JP, & Klein JD (2015). Trends in electronic cigarette use among U.S. adults: Use is increasing in both smokers and nonsmokers. *Nicotine & Tobacco Research*, 17(10), 1195–1202. 10.1093/ntr/ntu213 [PubMed: 25381306]
- Miech RA, O'Malley PM, Johnston LD, & Patrick ME (2016). E-Cigarettes and the drug use patterns of adolescents. *Nicotine & Tobacco Research*, 18(5), 654–659. 10.1093/ntr/ntv217 [PubMed: 26416823]
- Moeller SJ, Fink DS, Gbedemah M, Hasin DS, Galea S, Zvolensky MJ, & Goodwin RD (2018). Trends in illicit drug use among smokers and non-smokers in the United States. *The Journal of Clinical Psychiatry*, 79(3), 2002–2014. 10.4088/JCP.17m11718
- Parker MA (2019, 2). Comorbid drug use disorders and affective disorders as vulnerabilities to current smoking. Paper presented at the SRNT 25th Annual Meeting, San Francisco, CA Retrieved from https://cdn.ymaws.com/www.srnt.org/resource/resmgr/SRNT19_Abstracts.pdf
- Parker MA, & Anthony JC (2015). Epidemiological evidence on extra-medical opioid prescription use: Rapid transitions from newly incident use to dependence among 12–21 year olds in the United States using meta-analysis, 2002–2013. *PeerJ*, 3, e1340 10.7717/peerj.1340 [PubMed: 26623183]
- Parker MA, Pearson JL, & Villanti AC (2019). Limited utility of detailed e-cigarette use measures: An analysis of NESARC-III. *Addictive Behaviors*, 97, 56–62. 10.1016/j.addbeh.2019.05.001 [PubMed: 31150991]
- Pearson JL, Hitchman SC, Brose LS, Bauld L, Glasser AM, Villanti AC, ... Cohen JE (2018). Recommended core items to assess e-cigarette use in population-based surveys. *Tobacco Control*, 27, 341–346. 10.1136/tobaccocontrol-2016-053541 [PubMed: 28624764]
- Phillips E (2017). Tobacco product use among adults —United States, 2015. *MMWR. Morbidity and Mortality Weekly Report*, 66(44), 1209–1215. 10.15585/mmwr.mm6644a2 [PubMed: 29121001]
- Schoenborn C, & Gindi R (2015). Electronic cigarette use among adults: United States, 2014 (NCHS Data Brief No. 217) Retrieved from National Center for Health Statistics website: <https://www.cdc.gov/nchs/data/databriefs/db217.pdf>
- Sharapova SR, Singh T, Agaku IT, Kennedy SM, & King BA (2017). Patterns of E-cigarette use frequency—National Adult Tobacco Survey, 2012–2014. *American Journal of Preventive Medicine*, 54(2), 284–288. 10.1016/j.amepre.2017.09.015 [PubMed: 29129463]
- Stata Corp. (2015). *Stata Statistical Software: Release 14* (Version 14) College Station, TX: Stata Corp LP.
- Stein MD, Caviness CM, Grimone K, Audet D, Borges A, & Anderson BJ (2015). E-cigarette knowledge, attitudes, and use in opioid dependent smokers. *Journal of Substance Abuse Treatment*, 52(Supplement C), 73–77. 10.1016/j.jsat.2014.11.002 [PubMed: 25483740]
- Villanti AC, Pearson JL, Glasser AM, Johnson AL, Collins LK, Niaura RS, & Abrams DB (2017). Frequency of youth E-cigarette and tobacco use patterns in the United States: Measurement precision is critical to inform Public Health. *Nicotine & Tobacco Research* 19(11), 1345–1350. 10.1093/ntr/ntw388 [PubMed: 28013271]
- Zale EL, Dorfman ML, Hooten WM, Warner DO, Zvolensky MJ, & Ditte JW (2015). Tobacco smoking, nicotine dependence, and patterns of prescription opioid misuse: Results from a nationally representative sample. *Nicotine & Tobacco Research*, 17(9), 1096–1103. 10.1093/ntr/ntu227 [PubMed: 25344958]

Zhu S,H, Gamst A, Lee M, Cummins S, Yin L, & Zoref L (2013). The use and perception of electronic cigarettes and snus among the U. S. Population. PLoS ONE, 8(10), e79332 10.1371/journal.pone.0079332 [PubMed: 24250756]

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Table 1.

Characteristics of e-cigarette users by use status and adjusted relative risk ratio (ARRR) estimates from a multinomial logistic regression comparing use status groups, 2012–2013 National Epidemiologic Survey on Alcohol and Related Conditions-III (n = 36,277).^{a,b}

	Never e-cigarette users (n = 34,513; 94.7%)		Past e-cigarette users (n = 1,292; 3.9%)		Current e-cigarette users (n = 472; 1.4%)	
	Weighted % (95% CI)		Weighted % (95% CI)	ARRR (95% CI)	Weighted % (95% CI)	ARRR (95% CI)
Male	47.7 (47.1, 48.3)		57.2 (53.6, 60.6)	1.2 (1.0, 1.4)	48.1 (42.6, 53.6)	0.9 (0.7, 1.1)
Race/ethnicity						
White, non-Hispanic (reference)	65.4 (63.9, 67.0)		79.5 (76.9, 81.9)	1.0	77.9 (73.6, 81.7)	1.0
Black, non-Hispanic	12.1 (10.8, 13.5)		5.7 (4.4, 7.3)	0.3 (0.2, 0.4)	6.1 (4.4, 8.6)	0.4 (0.3, 0.5)
Other, non-Hispanic	7.4 (6.5, 8.4)		5.7 (4.2, 7.7)	0.8 (0.6, 1.1)	6.7 (4.2, 10.5)	0.9 (0.6, 1.4)
Hispanic	15.1 (13.7, 16.5)		9.1 (7.4, 11.2)	0.5 (0.4, 0.7)	9.2 (6.9, 12.4)	0.6 (0.4, 0.8)
Age, years						
18–24	12.6 (12.0, 13.2)		21.7 (18.7, 25.1)	3.1 (2.4, 4.0)	20.4 (16.1, 25.7)	2.6 (1.8, 3.9)
25–34	16.5 (16.0, 17.1)		31.1 (28.2, 34.3)	3.2 (2.5, 4.1)	24.2 (20.2, 28.8)	2.0 (1.5, 12.7)
35–44	17.1 (16.5, 17.7)		17.8 (15.4, 20.4)	1.9 (1.5, 2.5)	19.6 (15.6, 24.3)	1.8 (1.3, 2.6)
45–54	18.7 (18.1, 19.3)		15.5 (13.2, 18.2)	1.4 (1.1, 1.9)	19.2 (14.1, 25.7)	1.5 (0.9, 2.3)
55+ (reference)	35.1 (34.1, 36.1)		13.8 (11.5, 16.5)	1.0	16.5 (13.0, 20.6)	1.0
Education						
Less than high-school	13.0 (12.2, 13.9)		13.0 (11.0, 15.4)	1.0 (0.8, 1.3)	12.2 (9.2, 16.0)	0.8 (0.5, 1.3)
High-school diploma	25.4 (24.4, 26.5)		32.7 (29.6, 36.0)	1.4 (1.1, 1.9)	30.2 (25.3, 35.6)	1.2 (0.8, 1.7)
Some college	32.6 (31.6, 33.5)		41.8 (38.6, 45.1)	1.7 (1.3, 2.1)	43.9 (38.3, 49.7)	1.5 (1.0, 2.2)
Bachelor's degree or more (reference)	29.0 (27.5, 30.6)		12.4 (10.2, 15.1)	1.0	13.7 (10.2, 18.2)	1.0
Current cigarette smoker	17.8 (17.0, 18.5)		80.8 (78.1, 83.2)	15.1 (12.5, 18.3)	81.4 (77.3, 84.9)	16.3 (12.2, 21.8)
Current cigar smoker	1.8 (1.6, 1.9)		6.1 (4.6, 8.0)	1.6 (1.1, 2.2)	5.7 (3.6, 8.8)	1.6 (1.0, 2.7)
Current pipe smoker	0.2 (0.2, 0.3)		1.7 (1.0, 2.7)	2.7 (1.2, 6.1)	1.1 (0.4, 2.6)	2.0 (0.8, 5.4)
Current snuff/chewing tobacco user	2.5 (2.2, 2.9)		6.3 (4.6, 8.7)	1.3 (0.8, 1.9)	4.8 (2.5, 9.0)	0.9 (0.5, 1.8)
Current alcohol drinker	57.4 (56.0, 58.7)		68.5 (65.4, 71.5)	1.0 (0.9, 1.2)	69.9 (63.7, 75.5)	1.2 (0.9, 1.6)
Current cannabis user	5.9 (5.5, 6.4)		22.5 (19.6, 25.7)	1.3 (1.0, 1.6)	18.7 (15.3, 22.6)	1.1 (0.8, 1.4)
Current extra-medical opioid user	2.2 (2.0, 2.4)		7.4 (5.6, 9.6)	1.5 (1.1, 2.1)	7.1 (5.0, 10.2)	1.6 (1.1, 2.4)
Past year anxiety	14.0 (13.3, 14.7)		21.4 (18.3, 24.8)	1.1 (0.9, 1.4)	23.1 (18.8, 28.0)	1.3 (0.9, 1.8)
Past year depression	8.7 (8.2, 9.1)		24.4 (21.3, 27.7)	1.3 (1.0, 1.6)	24.5 (19.9, 29.7)	1.2 (0.9, 1.6)

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Numbers may not sum to 100% due to rounding.

q Bolding denotes statistical significance at the $\alpha = 0.05$ level for the adjusted relative risk ratios (ARRR) from the multinomial logistic regression model with never users as the base outcome. Some estimates may not appear to be significant due to rounding. Reference categories for all binary variables not shown.

Table 2.

Characteristics of current e-cigarette users by frequency of use and adjusted relative risk ratio (ARRR) estimates from a multinomial logistic regression comparing frequency groups, 2012–2013 National Epidemiologic Survey on Alcohol and Related Conditions-III ($n = 472$).^{a,b,c}

	Infrequent e-cigarette users ($n = 188$; 38.1%)		Moderate e-cigarette users ($n = 146$; 32.9%)		Daily e-cigarette users ($n = 138$; 29.0%)	
	Weighted % (95% CI)		Weighted % (95% CI)	ARRR (95% CI)	Weighted % (95% CI)	ARRR (95% CI)
Overall	38.1 (32.6, 43.9)		32.9 (27.5, 38.8)	–	29.0 (24.7, 33.8)	–
Male	42.6 (33.5, 52.2)		45.0 (35.9, 54.5)	1.6 (0.9, 3.0)	58.7 (48.0, 68.6)	4.6 (2.3, 9.1)
Race/ethnicity						
White, non-Hispanic (reference)	73.6 (66.0, 80.0)		79.0 (71.3, 85.0)	1.0	82.4 (75.8, 87.5)	1.0
Black, non-Hispanic	6.2 (3.8, 9.9)		6.2 (3.3, 11.1)	0.8 (0.3, 2.0)	6.1 (3.4, 10.5)	0.8 (0.3, 2.2)
Other, non-Hispanic	8.3 (4.2, 15.8)		6.0 (3.0, 11.7)	1.0 (0.4, 2.5)	5.3 (2.8, 9.9)	0.8 (0.2, 3.1)
Hispanic	11.9 (7.5, 18.3)		8.8 (5.2, 14.5)	0.8 (0.3, 1.9)	6.3 (3.5, 11.0)	0.3 (0.1, 1.0)
Age, years						
18–24	27.6 (19.4, 37.7)		18.1 (11.6, 27.1)	0.6 (0.2, 1.8)	13.7 (8.3, 21.7)	0.2 (0.1, 0.7)
25–34	31.7 (24.1, 40.4)		24.8 (18.2, 32.9)	0.6 (0.2, 1.7)	13.8 (8.5, 21.7)	0.2 (0.1, 0.5)
35–44	16.1 (11.2, 22.6)		14.7 (9.8, 21.4)	0.8 (0.3, 1.9)	29.7 (20.4, 41.1)	0.9 (0.4, 2.1)
45–54	12.0 (7.4, 18.9)		27.7 (19.0, 38.5)	2.0 (0.8, 5.0)	19.1 (12.1, 28.9)	0.9 (0.4, 2.4)
55+ (reference)	12.5 (8.3, 18.5)		14.7 (9.0, 23.1)	1.0	23.6 (16.3, 33.0)	1.0
Education						
Less than high-school	14.6 (9.7, 21.4)		9.1 (5.5, 14.7)	0.5 (0.2, 1.3)	12.6 (7.2, 21.2)	0.8 (0.2, 2.7)
High-school diploma	30.9 (24.0, 38.8)		36.4 (27.9, 45.8)	0.9 (0.4, 2.0)	22.1 (15.1, 31.2)	0.5 (0.2, 1.6)
Some college	41.5 (33.4, 50.0)		40.7 (32.7, 49.3)	0.9 (0.5, 2.0)	50.8 (40.9, 60.6)	1.4 (0.6, 3.7)
Bachelor's degree or more (reference)	13.0 (8.6, 19.2)		13.9 (8.9, 21.0)	1.0	14.5 (8.2, 24.3)	1.0
Current cigarette smoker	86.9 (79.9, 91.7)		89.3 (81.1, 93.8)	1.2 (0.5, 2.9)	65.1 (55.5, 73.6)	0.3 (0.1, 0.6)
Current cigar smoker	5.2 (2.5, 10.6)		3.3 (1.1, 9.5)	1.0 (0.3, 3.1)	8.9 (4.5, 17.0)	3.2 (0.8, 13.0)
Current pipe smoker	1.0 (0.3, 3.4)		1.1 (0.3, 3.6)	0.6 (0.2, 2.3)	1.2 (0.2, 8.1)	1.0 (0.1, 12.2)
Current snuff/chewing tobacco user	7.4 (3.3, 15.9)		4.6 (1.8, 11.0)	0.4 (0.1, 1.3)	1.6 (0.2, 10.5)	0.2 (0.0, 1.9)
Current alcohol drinker	79.5 (72.1, 85.4)		68.1 (56.6, 77.8)	0.6 (0.3, 1.2)	59.3 (49.3, 68.7)	0.4 (0.2, 0.7)
Current cannabis user	21.0 (15.6, 27.7)		22.4 (16.0, 30.4)	1.3 (0.7, 2.7)	11.5 (7.1, 18.1)	0.6 (0.2, 1.6)
Current extra-medical opioid user	3.1 (1.7, 5.8)		9.5 (5.3, 16.4)	3.8 (1.4, 10.6)	9.7 (5.4, 16.8)	4.5 (1.4, 14.1)
Past year anxiety	20.9 (15.3, 27.9)		30.9 (22.7, 40.4)	1.4 (0.7, 2.6)	17.2 (11.0, 25.7)	0.8 (0.4, 1.6)

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Infrequent e-cigarette users (<i>n</i> = 188; 38.1%)			Moderate e-cigarette users (<i>n</i> = 146; 32.9%)			Daily e-cigarette users (<i>n</i> = 138; 29.0%)		
Weighted % (95% CI)			Weighted % (95% CI)			Weighted % (95% CI)		
ARRR (95% CI)			ARRR (95% CI)			ARRR (95% CI)		
Past year depression			24.8 (17.6, 33.8)			28.8 (20.0, 39.6)		
			1.1 (0.5, 2.3)			19.2 (13.4, 26.6)		
						1.3 (0.6, 2.5)		

^aNumbers may not sum to 100% due to rounding.

^bBolding denotes statistical significance at the alpha = 0.05 level for the adjusted relative risk ratios (ARRR) from the multinomial logistic regression model with infrequent use as the base outcome. Reference categories for all binary variables not shown.

^cE-cigarette status: Current = past 30 day use; Infrequent = 3 days of use per month; moderate = 1–6 days of use per week; daily = every-day use.