



Full length article

Problem alcohol use and healthcare utilization among persons with cannabis use disorder in the United States

William S. John^{a,*}, Li-Tzy Wu^{a,b,c,d,*}^a Department of Psychiatry and Behavioral Sciences, Duke University Medical Center, Durham, NC, USA^b Department of Medicine, Division of Geriatric Internal Medicine, Duke University Medical Center, Durham, NC, USA^c Duke Clinical Research Institute, Duke University Medical Center, Durham, NC, USA^d Center for Child and Family Policy, Sanford School of Public Policy, Duke University, Durham, NC, USA

ARTICLE INFO

Keywords:

Alcohol use disorder
Cannabis use
Cannabis use disorder
Healthcare utilization
Hospitalization

ABSTRACT

Background: The emergency department (ED) and hospital settings represent crucial opportunities for engaging treatment for cannabis use disorder (CUD). Thus, there is a need to identify factors associated with healthcare utilization among persons with CUD to improve screening and intervention approaches. Problematic alcohol use may be a salient risk factor.

Methods: Using data from the 2005–2013 National Surveys on Drug Use and Health, we determined factors, including different patterns of alcohol use, associated with past-year ED admission and inpatient hospitalization among persons aged 12 years or older meeting criteria for CUD in the past year (N = 16,757). We also determined the prevalence and correlates of problem alcohol use among persons with CUD to further inform its association with healthcare utilization.

Results: Among persons with CUD, 40.15% and 10.04% reported past-year ED admission and inpatient hospitalization, respectively. Severe alcohol use disorder (AUD) (≥ 6 AUD symptoms), female sex, Black race, low income, major depressive episode (MDE), and other substance use disorders were associated with increased odds of healthcare utilization; current (i.e., last month) alcohol use patterns were not. Persons with CUD that were males, ages 18–25 (vs. ages 12–17), Hispanic (vs. White), and with low income, other drug use disorders, or MDE had increased odds of AUD.

Conclusions: Findings suggest that screening and intervention efforts for improving treatment initiation or engagement for CUD may target cannabis-using women, blacks, low-income adults or those with severe AUD in the past year, another substance use disorder, or MDE.

1. Introduction

The emergency department (ED) is an important entry portal into the medical care system for individuals with severe substance use problems compared to non-users due to a lower attachment to primary care (Cunningham et al., 2009). According to the Drug Abuse Warning Network (DAWN), approximately 2.5 million ED visits in 2011 involved substance misuse or abuse (DAWN, 2011). The National Drug Intelligence Center (NDIC) estimates that healthcare costs for drug use-related nonhomicide ED visits is approximately \$161 million annually (NDIC, 2011). Moreover, a statewide survey revealed that ED patients with unmet treatment need for substance use were 81% more likely to be admitted to the hospital during their current ED visit (Rockett et al., 2005). Drug-related hospital admissions are estimated by the NDIC to cost an additional \$5.5 billion annually (NDIC, 2011). Therefore, these

healthcare settings represent critical opportunities for initiating and engaging substance use disorder (SUD) treatment in order to reduce problem use, injury recidivism, and high healthcare costs.

In particular, the use of screening, brief intervention, and referral to treatment (SBIRT) approaches has shown efficacy for ED patients with problem alcohol use and has received endorsement by the American College of Emergency Physicians (ACEP) for this application (ACEP, 2017). On the other hand, efficacy for SBIRT approaches remains to be definitively demonstrated and thus recommended for ED patients with problem drug use, despite the fact that illicit drugs account for approximately 50% of alcohol/drug-related ED visits annually (SAMHSA and DAWN, 2011). Of particular concern, the DAWN indicated that cannabis was involved in 455,668 ED visits in 2011, which was the second most after cocaine among illicit drugs (SAMHSA and DAWN, 2011), and the rate of cannabis-related ED admissions and

* Corresponding authors at: Department of Psychiatry and Behavioral Sciences, Duke University Medical Center, Durham, NC, USA.

E-mail addresses: william.john@duke.edu (W.S. John), litzzy.wu@duke.edu (L.-T. Wu).

hospitalizations increased from 2004 to 2011 (Zhu and Wu, 2016). Moreover, cannabis use disorder (CUD) is the most prevalent illicit drug use disorder in the United States, which affected over 4 million people aged 12 or older in 2015 (Center for Behavioral Health Statistics and Quality (CBHSQ), 2016). Some data suggest that the prevalence of past-year CUD among adults in the U.S. has increased since 2002 (Hasin et al., 2015; Azofeifa et al., 2016), which may be associated with increased permissive attitudes toward cannabis use and the current watershed in legal status of cannabis for medical and recreational purposes (Pacek et al., 2015; Azofeifa et al., 2016; Martins et al., 2016; Maxwell and Mendelson, 2016).

However, despite the concern for CUD and cannabis-involved health resource utilization, few studies have examined the efficacy of SBIRT approaches for ED patients with problem cannabis use or CUD. Two single-site studies suggested effectiveness of a BI delivered in the ED to decrease cannabis use and cannabis-related problems (Bernstein et al., 2009; Woolard et al., 2013); however, a large multisite trial with greater heterogeneity and relatively higher problem severity found no effect of a BI to reduce cannabis use among ED patients whose primary problem substance was cannabis (Bogenschutz et al., 2014). Thus, it is critical to identify factors associated with healthcare utilization among persons with CUD in order to inform additional ED-based assessments, which can be used to guide more targeted intervention.

One factor associated with a higher risk-profile of CUD is the co-occurrence of problem alcohol use. Prior epidemiological data indicated that the majority of cannabis users also use alcohol (Pape et al., 2009; Terry-McElrath et al., 2013) and alcohol use disorder (AUD) is the most common substance-related comorbidity among those with CUD (Stinson et al., 2006; Khan et al., 2013). The co-use of alcohol and cannabis is associated with greater social problems (e.g., legal/accidents, work, fight, and relationship problems), academic problems, alcohol dependence, and depression compared to use of either substance alone (Midanik et al., 2007; Brière et al., 2011; Subbaraman and Kerr, 2015). One study suggested the presence of a positive association between marijuana problem severity and the frequency of alcohol use among cannabis users even when the two substances were not used simultaneously (Stein et al., 2014). Another study found that comorbid CUD and AUD was associated with a greater likelihood of major depressive episode, particularly among African Americans, compared to those with CUD or AUD alone and a greater arrest history compared to those with AUD alone (Pacek et al., 2012).

Despite this knowledge, data informing how to best screen for problem alcohol use among ED and hospital patients with CUD is lacking. Targeted and effective ED-based screening procedures are crucial given the limited time and competing priorities of medical providers in the ED. However, it is not clear whether certain patterns, time frames, or severity levels of problem alcohol use are associated with healthcare utilization among persons with CUD, which is necessary for guiding the most efficient screening strategies. To address these gaps in knowledge, we utilized data from the 2005–2013 National Surveys on Drug Use and Health (NSDUH) and examined the association of problem alcohol use and other factors with healthcare utilization (ED admission and inpatient hospitalization) among those with CUD. It is critical to leverage data from a national sample to enhance the generalizability of results to other ED and hospital settings. We also determined estimates of the prevalence and correlates of different patterns of alcohol use and AUD among those with CUD to identify population subgroups with elevated odds of having co-existing cannabis and alcohol problems. Overall, we hypothesized that severity of alcohol use would be positively related to ED admission and inpatient hospitalization among persons with CUD.

2. Methods

2.1. Data source

The annual NSDUH is a cross-sectional survey sponsored by the Substance Abuse and Mental Health Services Administration (SAMHSA) designed to provide ongoing estimates of the prevalence and correlates of drug use in the United States. The survey used multistage area probability sampling methods to select a representative sample of the civilian, non-institutionalized population aged ≥ 12 years. The sample included residents of households and non-institutionalized group quarters (shelters, college dormitories, group homes, military installations) from all 50 states and the District of Columbia.

NSDUH data collection was conducted in the households of eligible respondents for approximately one hour. Computer-assisted personal interviews were used to collect demographic information. Survey questions involving substance use, mental health, and other sensitive behaviors were assessed using audio computer-assisted self-interviewing (ACASI), in which the respondent either read the questions on a computer screen or listened to the questions through headphones and then directly entered responses into the computer.

Data for this study were combined from the 2005 through 2013 NSDUH public-use data sets (SAMHSA, 2006, 2014), as they used similar sampling methodology to allow analysis of the same variables across years; the pooled sample included 503,101 individuals aged 12 or older. Weighted response weights of household screening and interviewing for these years were 84–91% and 72–76%, respectively. Among the total sample, 3.33% ($N = 16,757$) met criteria for past-year CUD, which formed the analysis sample.

2.2. Study variables

2.2.1. Demographics

Self-reported sex, age, race/ethnicity, total family income, and residential location were included as covariates due to their association with CUD (Hasin and Grant, 2016). Survey year (categorical variable) was included as a control variable. Race/ethnicity was categorized into mutually exclusive groups that included non-Hispanic White, non-Hispanic Black, and Hispanic. Due to small sample size, other minority races including non-Hispanic Native-American (American Indian/Alaska-native), non-Hispanic native-Hawaiian/Pacific-Islander, non-Hispanic Asian-American, and mixed-race (> 1 race) were grouped together in a single category.

2.2.2. Cannabis use and CUD

Cannabis use was defined as any self-reported illicit (nonmedical) use of cannabis/hashish. Respondents were assessed according to their past-year use status and frequency of use. Past-year CUD was operationalized as meeting cannabis abuse or dependence based on the DSM-IV criteria. DSM-IV cannabis abuse was defined as having met ≥ 1 of four abuse criteria and determined not to be dependent upon cannabis; cannabis dependence was defined as having met ≥ 3 of six dependence criteria (APA, 2000). It is important to note that DSM-V removes the distinction between abuse and dependence, and CUD is defined by the presence of ≥ 2 of 11 criteria (APA, 2013).

2.2.3. Alcohol use and AUD

Alcohol use was defined as having fully consumed any alcoholic beverage, including a can/bottle of beer, a glass of wine/wine cooler, a shot of liquor, or a mixed drink containing liquor. Current binge alcohol use was defined as having ≥ 5 drinks at the same time or within a couple hours of each other on at least one day within the past 30 days. Current heavy alcohol use was defined as having ≥ 5 drinks at the same time or within a couple hours of each other on at least five days within the past 30 days. Four mutually exclusive levels of current (i.e., past month) alcohol use were determined that included: no current alcohol

Table 1
Selected characteristics and prevalence of healthcare utilization among persons aged 12 and older with past-year cannabis use disorder: NSDUH 2005–2013 (N = 16,757).

Persons with cannabis use disorder ^a	Total	ED admission		Inpatient hospitalization	
		Yes	No	Yes	No
Sample size, unweighted	N = 16,757	N = 7,037	N = 9,720	N = 1,645	N = 15,112
Weighted% (unweighted N)	Column% (N)	Row% (SE)	Row% (SE)	Row% (SE)	Row% (SE)
Total	100	40.15 (0.70)	59.85 (0.70)	10.04 (0.38)	89.96 (0.38)
Sex					
Female	33.19 (6,309)	45.78 (1.08)***	54.22 (1.08)	13.42 (0.72)***	86.58 (0.72)
Male	66.81 (10,448)	37.36 (0.76)	62.64 (0.76)	8.37 (0.50)	91.63 (0.50)
Age in years					
12–17	19.97 (5,814)	40.63 (0.91)	59.37 (0.91)	9.85 (0.42)***	90.15 (0.42)
18–25	45.19 (9,149)	40.42 (0.70)	59.58 (0.70)	8.36 (0.41)	91.64 (0.41)
26–34	16.84 (1,008)	38.63 (2.00)	61.37 (2.00)	8.89 (1.03)	91.11 (1.03)
35–49	12.55 (648)	40.78 (2.32)	59.22 (2.32)	13.29 (1.73)	86.71 (1.73)
50+	5.45 (138)	39.50 (5.45)	60.50 (5.45)	20.80 (4.28)	79.20 (4.28)
Race/ethnicity					
Non-Hispanic White	61.01 (9,783)	38.76 (0.92)***	61.24 (0.92)	9.55 (0.50)	90.45 (0.50)
Non-Hispanic Black	17.63 (2,501)	47.12 (1.27)	52.88 (1.27)	12.08 (1.07)	87.92 (1.07)
Hispanic	15.83 (2,788)	38.93 (1.80)	61.07 (1.80)	10.33 (1.05)	89.67 (1.05)
Other	5.53 (1,685)	36.76 (2.54)	63.24 (2.54)	8.18 (1.10)	91.82 (1.10)
Household income					
< \$20,000	30.15 (5,211)	45.24 (1.21)***	54.76 (1.21)	11.78 (0.73)***	88.22 (0.73)
\$20,000–\$49,999	33.75 (5,716)	41.06 (1.23)	58.94 (1.23)	10.99 (0.65)	89.01 (0.65)
\$50,000–\$74,999	13.38 (2,341)	38.01 (1.90)	61.99 (1.90)	8.69 (1.09)	91.31 (1.09)
≥ \$75,000	22.72 (3,489)	33.31 (1.50)	66.69 (1.50)	7.12 (0.69)	92.88 (0.69)
County type					
Non-metropolitan	4.38 (1,170)	46.36 (2.42)**	53.64 (2.42)	12.22 (1.44)	87.78 (1.44)
Small metropolitan	40.32 (8,291)	41.02 (1.00)	58.98 (1.00)	10.48 (0.56)	89.52 (0.56)
Large metropolitan	55.30 (7,296)	39.02 (0.85)	60.98 (0.85)	9.55 (0.51)	90.45 (0.51)
Any alcohol use-past month					
No	23.01 (4,059)	44.91 (1.51)***	55.09 (1.51)	14.08 (0.99)***	85.92 (0.99)
Yes	76.99 (12,698)	38.73 (0.71)	61.27 (0.71)	8.84 (0.39)	91.16 (0.39)
Level of alcohol use-past month					
Use but not binge use	16.28 (2,434)	38.03 (1.55)***	61.98 (1.55)	9.52 (0.91)***	90.48 (0.91)
Binge but not heavy use	35.04 (6,116)	40.00 (0.99)	60.00 (0.99)	9.43 (0.61)	90.57 (0.61)
Heavy use	25.67 (4,148)	37.45 (1.22)	62.55 (1.22)	7.60 (0.63)	92.40 (0.63)
Alcohol use disorder ^a -past year					
No	56.12 (9,101)	38.89 (0.99)*	61.11 (0.99)	9.47 (0.50)	90.53 (0.50)
Yes	43.88 (7,656)	41.77 (0.75)	58.23 (0.75)	10.78 (0.58)	89.22 (0.58)
Nicotine dependence-current					
No	61.68 (10,837)	36.20 (0.72)***	63.80 (0.72)	7.87 (0.44)***	92.13 (0.44)
Yes	38.32 (5,920)	46.52 (1.18)	53.48 (1.18)	13.54 (0.79)	86.46 (0.79)
Other drug use disorder ^{a,b} -past year					
No	80.24 (13,491)	37.32 (0.80)***	62.68 (0.80)	8.32 (0.44)***	91.68 (0.44)
Yes	19.76 (3,266)	51.64 (1.41)	48.36 (1.41)	17.03 (1.01)	82.97 (1.01)
Major depressive episode-past year					
No	81.42 (13,697)	37.89 (0.77)***	62.11 (0.77)	8.60 (0.44)***	91.40 (0.44)
Yes	18.58 (3,060)	50.07 (1.42)	49.93 (1.42)	16.35 (1.05)	83.65 (1.05)

Note: Sample size is unweighted; percentages are weighted estimates.

ED: emergency department; SE: standard error.

^a Defined as meeting DSM-IV criteria for abuse or dependence (APA, 2000).

^b Includes pain reliever, cocaine, hallucinogen, tranquilizer, stimulant, heroin, inhalant, or sedative use disorder.

Asterisks indicate * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ based on chi-square test.

use, alcohol use but no binge use, binge alcohol use but no heavy use, and heavy alcohol use. Given that the current definition of binge drinking is sex-specific (4+ drinks for females, 5+ drinks for males), results using these criteria were also reported to control for any confounding influence of sex. However, analysis using the sex-specific definition of binge drinking was only possible for years 2007–2013 of the NSDUH data.

Past-year AUD was defined as meeting DSM-IV criteria for ≥ 1 abuse symptoms and the absence of dependence symptoms or ≥ 3 dependence symptoms were met (APA, 2000). To indicate AUD severity, four mutually exclusive categories were created: no AUD symptoms, 1–3 AUD symptoms, 4–5 AUD symptoms, and ≥ 6 AUD symptoms.

2.2.4. Other behavioral health

Due to their association with cannabis use and CUD (Volkow et al., 2014), current nicotine dependence, drug use disorders, and major

depressive episode (MDE) were included as independent variables. Current nicotine dependence was determined based on whether respondents met criteria assessed by Nicotine Dependence Syndrome Scale (NDSS) and Fagerström Test of Nicotine Dependence (FTND) (Heatherton et al., 1991; Shiffman et al., 2004) in the past month. Past-year MDE was determined separately for adolescents and adults based on DSM-IV criteria (Kessler and Merikangas, 2004; Kessler et al., 2010). A person was defined as having past-year MDE if he or she had ≥ 5 of the nine symptoms for MDE in the same 2-week period during his/her lifetime and a period of time in the past 12 months when he/she felt depressed or lost interest or pleasure in daily activities for 2 weeks or longer. Other past-year drug use disorders included opioid, cocaine, hallucinogen, tranquilizer, stimulant, heroin, inhalant, and sedative use disorders, which were also assessed by DSM-IV criteria.

Table 2

Prevalence of current alcohol use and past-year alcohol use disorder among persons aged 12 and older with past-year cannabis use disorder: NSDUH 2005–2013 (N = 16,757).

Persons with cannabis use disorder ^a Weighted%	Past month pattern of alcohol use			Past year alcohol use disorder
	Alcohol use but not binge or heavy use Row% (95% CI)	Binge use but not heavy use Row% (95% CI)	Heavy use Row% (95% CI)	Alcohol use disorder ^a , yes Row% (95% CI)
Total	16.28 (15.34–17.22)	35.04 (33.86–36.22)	25.67 (24.52–26.83)	43.88 (42.51 – 45.25)
Sex				
Female†	19.73 (17.78–21.68)	34.40 (32.22–36.59)	18.84 (17.38–20.30)	41.96 (39.83 – 44.09)
Male	14.57 (13.34–15.80)	35.35 (33.89–36.81)	29.07 (27.63–30.51)	44.84 (43.16–46.51)
Age in years				
12–17†	14.17 (12.84–15.49)	33.01 (31.18–34.84)	16.85 (15.56–18.14)	43.12 (41.63 – 44.61)
18–25	15.04 (14.06–16.01)	38.73 (37.46–39.99)	30.30 (29.08–31.52)	47.48 (45.91 – 49.04)
26–34	20.10 (17.10–23.10)	35.20 (31.70–38.70)	24.65 (20.79–28.51)	39.51 (35.74 – 43.28)
35–49	16.93 (13.12–20.74)	31.75 (26.85–36.65)	26.38 (22.53–30.23)	42.62 (37.84 – 47.40)
50+	21.03 (12.19–29.86)	18.94 (9.70–28.18)	21.20 (12.69–29.71)	33.25 (22.66 – 43.85)
Race/ethnicity				
Non-Hispanic White†	15.36 (14.06–16.67)	34.39 (32.96–35.82)	28.92 (27.48–30.36)	44.34 (42.47 – 46.20)
Non-Hispanic Black	21.86 (18.95–24.78)	35.54 (32.31–38.76)	17.84 (15.21–20.46)	39.78 (36.62 – 42.93)
Hispanic	12.57 (10.51–14.64)	37.08 (34.02–40.13)	24.74 (21.37–28.12)	47.48 (44.54 – 50.42)
Other	19.25 (14.75–23.75)	34.76 (30.36–39.15)	17.48 (14.07 – 20.89)	41.64 (36.39–46.89)
Household income				
< \$20,000†	16.18 (14.19–18.17)	33.89 (31.51–36.28)	25.09 (23.09–27.10)	45.36 (43.08 – 47.65)
\$20,000–\$49,999	15.73 (13.94–17.53)	33.87 (31.84–35.90)	24.49 (22.63–26.34)	40.92 (38.65 – 43.20)
\$50,000–\$74,999	16.14 (13.65–18.64)	37.56 (34.00–41.13)	25.36 (22.67–28.05)	41.65 (38.77 – 44.53)
≥ \$75,000	17.31 (15.11–19.51)	36.80 (33.76–39.84)	28.39 (25.51–31.28)	47.62 (44.43–50.82)
County type				
Non-metropolitan†	10.40 (7.43–13.37)	34.98 (29.56–40.40)	26.35 (21.25–31.45)	46.72 (42.18–51.26)
Small metropolitan	14.49 (13.10–15.87)	33.75 (31.95–35.55)	26.52 (24.77–28.28)	44.46 (42.37–46.56)
Large-metropolitan	18.06 (16.71–19.40)	35.98 (34.35–37.62)	25.00 (23.30–26.70)	43.23 (41.57 – 44.89)
Nicotine dependence-current				
No†	17.18 (16.05–18.30)	35.98 (34.49–37.48)	25.17 (23.86–26.49)	42.48 (40.88 – 44.09)
Yes	14.84 (12.93–16.75)	33.52 (31.90–35.13)	26.48 (24.56–28.40)	46.13 (43.58 – 48.68)
Other drug use disorder ^{a,b} -past year				
No†	17.43 (16.37–18.49)	35.50 (34.07–36.94)	23.89 (22.54–25.24)	38.95 (37.40 – 40.50)
Yes	11.63 (9.76–13.50)	33.15 (30.74–35.56)	32.92 (30.19–35.66)	63.89 (60.69 – 67.09)
Major depressive episode-past year				
No†	16.03 (15.06–16.99)	35.80 (34.44–37.16)	26.18 (24.82–27.55)	42.49 (41.07 – 43.92)
Yes	17.39 (14.37–20.42)	31.69 (29.02–34.36)	23.45 (21.17–25.72)	49.97 (46.46–53.48)
Survey year				
2005†	14.74 (11.45–18.03)	36.02 (32.61–39.43)	30.40 (27.02–33.77)	50.99 (47.33–54.66)
2006	17.14 (13.87–20.41)	34.12 (30.52–37.71)	29.78 (26.62–32.94)	48.38 (45.12–51.63)
2007	12.42 (10.02–14.82)	34.37 (30.97–37.77)	32.56 (28.90–36.23)	51.16 (47.18–55.13)
2008	16.28 (13.33–19.23)	34.53 (31.69–37.37)	27.14 (23.95–30.33)	44.67 (41.39–47.95)
2009	15.84 (12.74–18.93)	35.36 (30.75–39.96)	27.10 (23.31–30.88)	45.83 (41.68 – 49.98)
2010	18.72 (15.22–22.21)	33.64 (30.11–37.16)	22.71 (19.50–25.92)	38.93 (35.76 – 42.09)
2011	17.20 (14.79–19.61)	33.69 (30.05–37.34)	22.39 (19.20–25.58)	40.95 (37.48 – 44.43)
2012	16.60 (13.97–19.23)	36.10 (31.68–40.52)	21.72 (18.79–24.65)	39.46 (35.11–43.80)
2013	17.14 (14.27–20.01)	37.60 (33.53–41.67)	18.08 (14.61–21.56)	35.67 (31.22–40.11)

Note: Sample size is unweighted; percentages are weighted estimates.

CI: Confidence interval.

Boldface: Estimate significantly differed from reference group (†) within each column ($p < 0.05$).

^a Defined as meeting DSM-IV criteria for abuse or dependence (APA, 2000).

^b Includes pain reliever, cocaine, hallucinogen, tranquilizer, stimulant, heroin, inhalant, or sedative use disorder.

2.2.1. ED admission and inpatient hospitalization

ED admission was defined as having one or more admissions to an ED in the previous 12 months. Inpatient hospitalization was defined as having stayed overnight or longer as an inpatient in a hospital during the previous 12 months.

2.3. Data analysis

Weighted percentages were calculated for descriptive statistics of demographic variables and the prevalence of alcohol use and healthcare utilization among those meeting criteria for past-year CUD (N = 16,757). The prevalence of healthcare utilization by subgroups was compared using chi-square tests. A multinomial logistic regression model was used to estimate factors associated with current alcohol use among persons with CUD; a separate binary logistic regression model was used to estimate factors associated with past-year AUD. Furthermore, separate binary logistic regression models were used to estimate factors associated with past-year ED admission and inpatient

hospitalization among persons with CUD. All logistic regression models were adjusted for sex, age, race/ethnicity, family income, residential location, MDE, nicotine dependence, drug use disorders, and survey year (recoded as a categorical variable) to lessen their confounding effects. All analyses were conducted using SAS software (Version 9.4) and took into account the NSDUH's complex designs (i.e., weighting, clustering).

3. Results

3.1. Descriptive characteristics of persons with CUD (Table 1)

Among persons aged 12 or older with past-year CUD, the largest proportion were male (66.81%), 18–25 years old (45.19%), White (61.01%), residents of areas with a high population density (55.30%), and had a total family income of \$20,000–\$49,000 (33.75%). A large proportion of persons with CUD (76.99%) reported current alcohol use (any), while 16.28% reported alcohol use but not binge use, 35.04%

reported binge use but not heavy use, and 25.67% reported heavy use. Furthermore, 43.88% of those with CUD met criteria for AUD in the past year .

The prevalence of past-year ED admission was higher among those with CUD (40.15%) compared to those without CUD (28.11%); however, the prevalence of past-year inpatient hospitalization was not different among those with (10.04%) and without (10.29%) CUD (Table S1). Moreover, the prevalence of ED admission was higher among each population subgroup with CUD than without CUD while the prevalence of inpatient hospitalization was higher among 12–17 year olds with CUD (9.85%) compared to 12–17 year olds without CUD (4.78%) and among 35–49 year olds with CUD (13.29%) compared to 35–49 year olds without CUD (8.02%) (Table S1). Among those with CUD reporting past-year inpatient hospitalization, 84.4% (N = 1,389) also reported past-year ED admission. The subgroups of persons with CUD that had the highest prevalence of ED admission were those with comorbid drug use disorders (51.64%) followed by those with MDE (50.07%). Persons with CUD aged 50 years or older had the highest prevalence (20.80%) of past-year inpatient hospitalization. Furthermore, chi-square tests demonstrated that past-year AUD was associated with greater prevalence of ED admission but current alcohol use was not.

3.2. Prevalence of current alcohol use and past-year AUD among persons with CUD (Table 2)

Among persons with CUD, the prevalence of current alcohol use but no binge use in females (19.73%) was higher than in males (14.57%). However, current heavy alcohol use was more prevalent among males with CUD (29.07%) compared to females with CUD (18.84%). Across different groups of persons with CUD, current binge alcohol use, heavy alcohol use, and past-year AUD was most prevalent among 18–25 year olds. The prevalence of current alcohol use but no binge use was higher among Blacks with CUD (21.86%) compared to Whites with CUD (15.36%). The prevalence of current heavy alcohol use among those with CUD was higher among Whites (28.92%) compared to Blacks (17.84%) and other races (17.48%). Furthermore, there was a significant decrease in prevalence of heavy alcohol use and AUD among those with CUD for years 2010 through 2013 compared to 2005 .

When the data were analyzed to account for the sex-specific definition of binge drinking, prevalence patterns of current alcohol use levels were generally similar (Table S2).

3.3. Correlates of current problem alcohol use and AUD among persons with CUD (Table 3)

Among persons with CUD, male sex (vs. female), ages 18–25, 26–34, 35–49 (vs. ages 12–17), White race (vs. other), and high family income (vs. < \$20,000) was associated with increased odds of current binge alcohol use and heavy use. Male sex (vs. female), ages 18–25 (vs. ages 12–17), Hispanic race (vs. White), and low income (vs. \$20,000–\$49,000) were associated with increased odds of past-year AUD .

Regarding the association of other behavioral health indicators among persons with CUD, current nicotine dependence was negatively associated with current alcohol use but not binge use, and binge alcohol use and other drug use disorders were positively associated with current heavy alcohol use and past-year AUD. MDE among persons with CUD was associated with lower odds of current binge alcohol use but higher odds of AUD. Moreover, there were decreased odds of heavy alcohol use and AUD among those with CUD from 2010 to 2013 (vs. 2005).

Adjusted odds ratios of current alcohol use levels among those with CUD were generally similar when using the sex-specific definition of binge drinking (Table S3).

3.4. Association between past-year ED admission and inpatient hospitalization among persons with CUD (Table 4)

Among persons with CUD, past-year AUD was not associated with ED admission or inpatient hospitalization (Table S4). However, severe AUD (≥ 6 symptoms) was associated with increased odds of both ED admission and inpatient hospitalization. In addition, female sex (vs. male), Black race (vs. White), < \$20,000 household income (vs. \geq \$75,000), current nicotine dependence, other drug use disorder, and MDE were associated with increased odds of both ED admission and inpatient hospitalization. Ages ≥ 50 years (vs. ages 12–17) was associated with increased odds of inpatient hospitalization only .

4. Discussion

Drawing from a national sample, the main finding was that individuals with CUD and severe AUD (≥ 6 symptoms) had higher odds of past-year ED admission and inpatient hospitalization compared to those with CUD and no AUD symptoms. In contrast, we found that current alcohol use patterns were not associated with healthcare utilization among persons with CUD. These findings supported our hypothesis that healthcare utilization among persons with CUD was associated with greater severity of problem alcohol use; however, our results indicated that timeframe and number of diagnostic criteria of problem alcohol use were important factors. Our results may have important implications for targeted screening for problem alcohol use among ED or hospital patients with CUD to identify those who may be most at risk for injury recidivism and consequent healthcare utilization. Specifically, the present findings suggest screening for past-year AUD criteria as opposed to current drinking patterns. This is not to say that current drinking patterns among ED patients with CUD are irrelevant, especially given their association with a number of increased problems (Midanik et al., 2007; Brière et al., 2011; Subbaraman and Kerr, 2015; Terry-McElrath et al., 2014). However, screening for substance use problems in healthcare settings is a challenge due to limited time and competing priorities. Thus, the prioritization of past-year AUD severity among alcohol-related screening foci in ED/inpatient patients with CUD may be a useful method for identifying those at-risk for healthcare utilization.

Studies have demonstrated the potential benefit of using risk-stratified screening procedures in guiding the appropriate degree of intervention in ED or hospital settings. For instance, brief interventions appear to be effective for reducing problems in ED patients with mild to moderate severity of problem substance or alcohol use (Kaner et al., 2007; D'Onofrio et al., 2012; Jonas et al., 2012; Jonas et al., 2012), but not for those with high severity levels (Gentilello et al., 1999; Bogenschutz et al., 2011). Further research is needed to extend the use of risk-stratified screening specifically for ED/hospital patients with CUD and to examine the efficacy of more intensive interventions given that ED patients with cannabis use problems are more likely to constitute a severe subset, often associated with polysubstance abuse (Zhu and Wu, 2016). However, ED care alone is likely inadequate for persons with CUD (Bogenschultz et al., 2014; Merchant et al., 2015). Therefore, efforts devoted to providing continued care through linkage to other community services will be necessary to reduce the odds of future adverse medical events and costly healthcare utilization.

To further inform the association with healthcare utilization, we also examined the prevalence and correlates of problem alcohol use among those with CUD. We found that 43.88% of those with CUD had comorbid AUD. Regarding current alcohol use patterns, individuals with CUD had the highest prevalence of binge use (35.04%) compared to heavy use (25.67%) and use but no binge use (16.28%). Our data revealed that among persons with CUD, male sex (vs. female), ages 18–25 (vs. ages 12–17), and Hispanic race (vs. White) were positively associated with AUD. Moreover, other drug use disorders and MDE were also positively associated with AUD among persons with CUD,

Table 3

Adjusted odds ratios of current alcohol use and past-year alcohol use disorder among persons aged 12 or older with past-year cannabis use disorder: NSDUH 2005–2013 (N = 16,757).

Persons with cannabis use disorder ^a	Alcohol use but not binge or heavy use (vs. no use) AOR (95% CI)	Binge but not heavy use (vs. no use) AOR (95% CI)	Heavy use (vs. no use) AOR (95% CI)	Alcohol use disorder ^a (vs. no) AOR (95% CI)
Sex				
Female	1.00	1.00	1.00	1.00
Male	0.85 (0.69–1.06)	1.20 (1.04–1.39)	1.81 (1.55–2.11)	1.21 (1.07–1.36)
Age in years				
12–17	1.00	1.00	1.00	1.00
18–25	2.54 (2.21–2.91)	2.77 (2.44–3.16)	4.26 (3.69–4.91)	1.23 (1.11–1.36)
26–34	2.74 (2.12–3.55)	2.03 (1.60–2.56)	2.79 (2.04–3.81)	0.89 (0.74–1.08)
35–49	1.83 (1.30–2.59)	1.44 (1.06–1.95)	2.25 (1.79–2.82)	0.92 (0.75–1.14)
50+	1.62 (0.89–2.95)	0.60 (0.32–1.14)	1.32 (0.78–2.26)	0.65 (0.40–1.07)
Race/ethnicity				
Non-Hispanic White	1.00	1.00	1.00	1.00
Non-Hispanic Black	1.16 (0.93–1.45)	0.88 (0.74–1.05)	0.53 (0.43–0.66)	0.96 (0.82–1.13)
Hispanic	0.68 (0.53–0.87)	0.89 (0.73–1.07)	0.73 (0.59–0.91)	1.19 (1.05–1.36)
Other	0.91 (0.63–1.31)	0.71 (0.53–0.96)	0.45 (0.32–0.62)	0.95 (0.75–1.22)
Household income				
< \$20,000	1.00	1.00	1.00	1.00
\$20,000–\$49,999	0.99 (0.77–1.28)	1.01 (0.85–1.19)	0.97 (0.80–1.16)	0.85 (0.75–0.97)
\$50,000–\$74,999	1.28 (0.91–1.80)	1.41 (1.08–1.85)	1.26 (0.98–1.62)	0.90 (0.78–1.04)
≥ \$75,000	1.58 (1.23–2.04)	1.56 (1.24–1.96)	1.54 (1.21–1.95)	1.15 (0.95–1.40)
County type				
Non-metropolitan	1.00	1.00	1.00	1.00
Small metropolitan	1.49 (1.00–2.21)	1.06 (0.82–1.38)	1.10 (0.80–1.50)	0.91 (0.75–1.11)
Large metropolitan	2.04 (1.33–3.11)	1.27 (0.95–1.70)	1.23 (0.87–1.76)	0.88 (0.73–1.07)
Nicotine dependence-current				
No	1.00	1.00	1.00	1.00
Yes	0.75 (0.61–0.92)	0.85 (0.75–0.96)	0.86 (0.73–1.01)	1.07 (0.96–1.20)
Other drug use disorder^{a,b}-past year				
No	1.00	1.00	1.00	1.00
Yes	0.80 (0.62–1.04)	1.10 (0.91–1.33)	1.56 (1.23–1.96)	2.66 (2.30–3.08)
Major depressive episode-past year				
No	1.00	1.00	1.00	1.00
Yes	0.93 (0.75–1.17)	0.80 (0.69–0.93)	0.84 (0.69–1.02)	1.31 (1.13–1.52)

Note: A multinomial logistic regression model was used to examine factors associated with current alcohol use; a binary logistic regression model was used to examine factors associated with alcohol use disorder. Each logistic regression model included variables listed in the first column and was adjusted for survey year.

CI: Confidence interval.

Boldface: Estimate significantly differed from reference group ($p < 0.05$).

^a Defined as meeting DSM-IV criteria for abuse or dependence (APA, 2000).

^b Includes pain reliever, cocaine, hallucinogen, tranquilizer, stimulant, heroin, inhalant, or sedative use disorder.

which is consistent with other studies using national survey data (Pacek et al., 2012, 2013). Additional research is needed to elucidate the relationship between these comorbidities; however, these data further highlight the need for integrated care, consisting of both drug and mental health treatment modalities, to address multiple comorbidities among individuals with CUD (Copeland et al., 2009).

The present study also revealed that certain demographic characteristics among persons with CUD were associated with increased odds of ED and inpatient care utilization including female sex (vs. male), Black race (vs. White), and low income. CUD among socioeconomically disadvantaged subgroups may be related to increased cannabis use as a coping behavior (Bujarski et al., 2012), which ultimately may lead to greater health problems or injury thereby requiring ED/inpatient care. Other research also indicates that these demographic subgroups with CUD may be at higher risk than others. For instance, non-Hispanic Blacks had the highest increase in CUD prevalence (from 2001 to 2013) and cannabis-involved ED visits (from 2004 to 2011) across any racial/ethnic group (Hasin et al., 2015; Zhu and Wu, 2016). Previous research also showed that persons with lower incomes had the highest odds of CUD and greatest increase in CUD prevalence from 2001 to 2013 (Hasin et al., 2015; Hasin et al., 2015, 2016). Furthermore, although males have higher odds of CUD than females and represent a larger proportion of ED patients with problematic cannabis use than females (Bogenschutz et al., 2011; Hasin et al., 2015), our results suggest that females with CUD may be more vulnerable to adverse consequences that lead to ED admission or hospitalization. Thus, these findings further imply that CUD may manifest

differently in males and females and suggest the need for sex-specific screening thresholds, which is supported by other studies showing greater substance use severity in male ED patients compared to females (Sanjuan et al., 2014; Beaudoin et al., 2015). Our results also indicated that nicotine dependence, other drug use disorders, and MDE were associated with increased odds of healthcare utilization among persons with CUD. Taken together, these subgroups of persons with CUD who have elevated odds of ED or inpatient care may be targeted for screening and intervention in the ED or in other linkage services to help initiate and engage in treatment. Future studies are needed for determining the prioritization of risk factors for screening and intervention given that some independent factors (e.g., other drug use disorders, MDE) had stronger associations with healthcare utilization than others (e.g., AUD).

The results of this study should be interpreted within the following limitations. First, the NSDUH relies on respondents' self-reports, which is subject to under-reporting and recall bias. However, the use of ACASI technology helps to reduce such biases (Turner et al., 1998). The present study does not include data from those in active-duty military service and institutional group quarters (hospitals, prisons, nursing homes, treatment centers) as these subpopulations were excluded from the NSDUH. Secondly, the cross-sectional design of the NSDUH precludes causal interpretation of identified correlates of healthcare utilization and problem alcohol use. For instance, it is unknown whether, or how often, healthcare utilization was the result of seeking substance use treatment, comorbid medical or psychiatric conditions, or acute medical problems/trauma. Future studies examining the direct link between

Table 4

Adjusted odds ratios of past-year emergency department admission and inpatient hospitalization among persons aged 12 and older with past-year cannabis use disorder: NSDUH 2005–2013 (N = 16,757).

Persons with cannabis use disorder ^a	Any ED admission	Inpatient hospitalization
Adjusted odds ratio (AOR)	AOR (95% CI)	AOR (95% CI)
Alcohol use disorder ^a -past year		
No AUD symptoms	1.00	1.00
1–3 AUD symptoms	0.96 (0.86–1.08)	0.88 (0.71–1.09)
4–5 AUD symptoms	1.00 (0.85–1.18)	0.92 (0.72–1.17)
6 or more AUD symptoms	1.24 (1.02–1.50)	1.40 (1.07–1.82)
Sex		
Female	1.00	1.00
Male	0.77 (0.69–0.85)	0.64 (0.52–0.78)
Age in years		
12–17	1.00	1.00
18–25	0.97 (0.87–1.07)	0.84 (0.72–0.98)
26–34	0.85 (0.69–1.05)	0.84 (0.62–1.13)
35–49	0.88 (0.71–1.08)	1.22 (0.88–1.71)
50+	0.79 (0.50–1.24)	2.02 (1.15–3.53)
Race		
Non-Hispanic White	1.00	1.00
Non-Hispanic Black	1.47 (1.31–1.64)	1.42 (1.09–1.85)
Hispanic	1.03 (0.86–1.24)	1.22 (0.94–1.57)
Other	0.92 (0.72–1.19)	0.94 (0.69–1.29)
Household income		
< \$20,000	1.00	1.00
\$20,000–\$49,999	0.89 (0.77–1.02)	0.97 (0.78–1.22)
\$50,000–\$74,999	0.83 (0.69–1.00)	0.83 (0.60–1.13)
≥ 75,000	0.71 (0.59–0.87)	0.74 (0.55–0.98)
County type		
Non-metropolitan	1.00	1.00
Small metropolitan	0.86 (0.70–1.05)	0.87 (0.66–1.14)
Large metropolitan	0.82 (0.67–1.01)	0.84 (0.63–1.13)
Nicotine dependence-current		
No	1.00	1.00
Yes	1.39 (1.26–1.54)	1.50 (1.22–1.84)
Other drug use disorder ^{a,b} -past year		
No	1.00	1.00
Yes	1.59 (1.36–1.85)	1.81 (1.44–2.28)
Major depressive episode-past year		
No	1.00	1.00
Yes	1.42 (1.22–1.66)	1.57 (1.25–1.97)

Note: each logistic regression model included variables listed in the first column and adjusted for survey year.

ED: emergency department; CI: Confidence interval.

Boldface: Estimate significantly differed from reference group ($p < 0.05$).

^a Defined as meeting DSM-IV criteria for abuse or dependence (APA, 2000).

^b Includes pain reliever, cocaine, hallucinogen, tranquilizer, stimulant, heroin, inhalant, or sedative use disorder.

alcohol use and other factors with healthcare utilization among patients with CUD may inform more targeted interventions. The present study was also unable to measure synthetic cannabinoid use or newer forms of cannabis administration (vaping), which may have been important factors associated with healthcare utilization. Finally, ED and inpatient care represent different treatment settings; however, the path to inpatient hospitalization usually starts with ED admission. Hence, the factors associated with inpatient hospitalization may be representative of a more vulnerable or severe subset of patients with CUD.

In conclusion, the present findings from a large national sample of persons with CUD provided clinically useful information related to factors associated with problem alcohol use and health resource utilization. These data on ED admission and inpatient hospitalization are clinically relevant for SBIRT efforts. Given competing medical priorities, the implementation of targeted or focused screening of and intervention for individuals with CUD is an important first step that dictates the level of care one receives. Our findings suggest that persons

with CUD that are female, Black, or low-income, as well as those with another substance use disorder or MDE may be targeted for such efforts. The development of an empirical knowledge base for CUD and infrastructure support to enable medical providers to identify high-risk patients for utilizing costly medical services is critical to providing the most appropriate treatment in order to reduce serious medical problems and high healthcare costs. As a result, targeted and effective SBIRT approaches for CUD should continue to be developed, especially with regard to screening and implementing interventions for co-occurring problem alcohol use.

Conflicts of interest

The authors have no conflicts of interest to disclose.

Role of the funding source

This work was made possible by research support from the U.S. National Institutes of Health (R01MD007658, R01DA019623, and UG1DA040317; PI, Li-Tzy Wu). The sponsoring agency had no further role in the study design and analysis, the writing of the report, or the decision to submit the paper for publication. The opinions expressed in this paper are solely those of the authors.

Contributors

William S. John contributed to the design and concept for this manuscript, conducted data analysis, and drafted the manuscripts. Li-Tzy Wu contributed to the design and concept for this manuscript, revised/edited the manuscripts, and supervised the work. All authors approved of the final manuscript.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.drugalcdep.2017.05.035>.

References

- American College of Emergency Physicians, 2017. Alcohol Screening the Emergency Department. (8 May 2017).
- American Psychiatric Association (APA), 2000. Diagnostic and Statistical Manual of Mental Disorders DSM-IV-TR, 4th ed. American Psychiatric Association, Washington, DC.
- American Psychiatric Association (APA), 2013. Diagnostic and Statistical Manual of Mental Disorders, 5th ed. American Psychiatric Association, Washington, DC.
- Azofeifa, A., Mattson, M.E., Schauer, G., McAfee, T., Grant, A., Lyerla, R., 2016. National estimates of marijuana use and related indicators—National Survey on Drug use and Health, United States, 2002–2014. *MMWR Surveill. Summ.* 65, 1–25.
- Beaudoin, F.L., Baird, J., Liu, T., Merchant, R.C., 2015. Sex differences in substance use among adult emergency department patients: prevalence, severity, and need for intervention. *Acad. Emerg. Med.* 22, 1307–1315.
- Bernstein, E., Edwards, E., Dorfman, D., Heeren, T., Bliss, C., Bernstein, J., 2009. Screening and brief intervention to reduce marijuana use among youth and young adults in a pediatric emergency department. *Acad. Emerg. Med.* 16, 1174–1185.
- Bogenschutz, M.P., Donovan, D.M., Mandler, R.N., Perl, H.I., Forchimes, A.A., Crandall, C., Brière, F.N., Fallu, J.S., Descheneaux, A., Janosz, M., 2011. Predictors and consequences of simultaneous alcohol and cannabis use in adolescents. *Addict. Behav.* 36, 785–788.
- Bujarski, S.J., Norberg, M.M., Copeland, J., 2012. The association between distress tolerance and cannabis use-related problems: the mediating and moderating roles of coping motives and gender. *Addict. Behav.* 37, 1181–1184.
- Center for Behavioral Health Statistics and Quality (CBHSQ), 2016. 2015 National Survey on Drug Use and Health: Detailed Tables. Substance Abuse and Mental Health Services Administration, Rockville, MD.
- Copeland, J., Frewen, A., Elkins, K., 2009. Management of Cannabis Use Disorder and Related Issues (NCPC Australia). National Cannabis Prevention and Information Centre Available from: <https://ncpic.org.au/media/1594/management-of-cannabis-use-disorder-and-relatedissues-a-clinicians-guide.pdf>.
- Gentilello, L.M., Rivara, F.P., Donovan, D.M., Jurkovich, G.J., Daranciang, E., Dunn, C.W., Villaveces, A., Copass, M., Ries, R.R., 1999. Alcohol interventions in a trauma center as a means of reducing the risk of injury recurrence. *Ann. Surg.* 230, 473–480.

- (Discussion 480–483).
- Hasin, D.S., Grant, B., 2016. NESARC findings on increased prevalence of marijuana use disorders-consistent with other sources of information. *JAMA Psychiatry* 73, 532.
- Hasin, D.S., Saha, T.D., Kerridge, B.T., Goldstein, R.B., Chou, S.P., Zhang, H., Jung, J., Pickering, R.P., Ruan, W.J., Smith, S.M., Huang, B., Grant, B.F., 2015. Prevalence of marijuana use disorders in the United States between 2001 and 2002 and 2012–2013. *JAMA Psychiatry* 72, 1235–1242.
- Heatherton, T.F., Kozlowski, L.T., Frecker, R.C., Fagerström, K.O., 1991. The Fagerström test for nicotine dependence: a revision of the Fagerström tolerance questionnaire. *Br. J. Addict.* 86, 1119–1127.
- Jonas, D.E., Garbutt, J.C., Brown, J.M., Amick, H.R., Brownley, K.A., Council, C.L., Viera, A.J., Wilkins, T.M., Schwartz, C.J., Richmond, E.M., Yeatts, J., Swinson Evans, T., Wood, S.D., Harris, R.P., 2012. Screening, Behavioral Counseling, and Referral in Primary Care to Reduce Alcohol Misuse. Agency for Healthcare Research and Quality, Rockville, MD.
- Kaner, E.F., Beyer, F., Dickinson, H.O., Pienaar, E., Campbell, F., Schlesinger, C., Heather, N., Saunders, J., Burnand, B., 2007. Effectiveness of brief alcohol interventions in primary care populations. *Cochrane Database Syst. Rev.* 18, CD004148.
- Kessler, R.C., Merikangas, K.R., 2004. The national comorbidity survey replication (NCS-R): background and aims. *Int. J. Methods Psychiatry Res.* 13, 60–68.
- Kessler, R.C., Birnbaum, H., Bromet, E., Hwang, I., Sampson, N., Shahly, V., 2010. Age differences in major depression: results from the national comorbidity survey replication (NCS-R). *Psychol. Med.* 40, 225–237.
- Khan, S.S., Secades-Villa, R., Okuda, M., Wang, S., Pérez-Fuentes, G., Kerridge, B.T., Blanco, C., 2013. Gender differences in cannabis use disorders: results from the National Epidemiologic Survey of Alcohol and Related Conditions. *Drug Alcohol Depend.* 130, 101–108.
- Martins, S.S., Mauro, C.M., Santaella-Tenorio, J., Kim, J.H., Cerda, M., Keyes, K.M., Hasin, D.S., Galea, S., Wall, M., 2016. State-level medical marijuana laws, marijuana use and perceived availability of marijuana among the general U.S. population. *Drug Alcohol Depend.* 169, 26–32.
- Maxwell, J.C., Mendelson, B., 2016. What do we know now about the impact of the laws related to marijuana? *J. Addict. Med.* 10, 3–12.
- Merchant, R.C., Baird, J.R., Liu, T., 2015. Short-term efficacy of a brief intervention to reduce drug misuse and increase drug treatment utilization among adult emergency department patients. *Acad. Emerg. Med.* 22, 1172–1180.
- Midanik, L.T., Tam, T.W., Weisner, C., 2007. Concurrent and simultaneous drug and alcohol use: results of the 2000 National Alcohol Survey. *Drug Alcohol Depend.* 90, 72–80.
- NDIC, 2011. The Economic Impact of Illicit Drug Use on American Society.
- Pacek, L.R., Malcolm, R.J., Martins, S.S., 2012. Race/ethnicity differences between alcohol, marijuana, and co-occurring alcohol and marijuana use disorders and their association with public health and social problems using a national sample. *Am. J. Addict.* 21, 435–444.
- Pacek, L.R., Martins, S.S., Crum, R.M., 2013. The bidirectional relationships between alcohol, cannabis, co-occurring alcohol and cannabis use disorders with major depressive disorder: results from a national sample. *J. Affect. Disord.* 148, 188–195.
- Pacek, L.R., Mauro, P.M., Martins, S.S., 2015. Perceived risk of regular cannabis use in the United States from 2002 to 2012: differences by sex, age, and race/ethnicity. *Drug Alcohol Depend.* 149, 232–244.
- Pape, H., Rossow, I., Storz, E.E., 2009. Under double influence: assessment of simultaneous alcohol and cannabis use in general youth populations. *Drug Alcohol Depend.* 101, 69–73.
- Rockett, I.R., Putnam, S.L., Jia, H., Chang, C.F., Smith, G.S., 2005. Unmet substance abuse treatment need, health services utilization, and cost: a population-based emergency department study. *Ann. Emerg. Med.* 45, 118–127.
- Substance Abuse and Mental Health Services Administration (SAMHSA), Drug Abuse Warning Network (DAWN), 2011. National Estimates of Drug-Related Emergency Department Visits. HHS Publication No. (SMA) 13–4760, DAWN Series D-39.
- Substance Abuse and Mental Health Services Administration, 2013. Rockville, MD.
- Substance Abuse and Mental Health Services Administration (SAMHSA), 2006. Results from the 2005 National Survey on Drug Use and Health: National Findings. NSDUH Series H-30, DHHS Publication No. SMA 06-4194. Substance Abuse and Mental Health Services Administration, Rockville, MD.
- Substance Abuse and Mental Health Services Administration (SAMHSA), 2014. Results from the 2013 National Survey on Drug Use and Health: Summary of National Findings. NSDUH Series H-48, HHS Publication No. (SMA) 14–4863. Substance Abuse and Mental Health Services Administration, Rockville, MD.
- Sanjuan, P.M., Rice, S.L., Witkiewitz, K., Mandler, R.N., Crandall, C., Bogenschutz, M.P., 2014. Alcohol, tobacco, and drug use among emergency department patients. *Drug Alcohol Depend.* 138, 32–38.
- Shiffman, S., Waters, A., Hickcox, M., 2004. The nicotine dependence syndrome scale: a multidimensional measure of nicotine dependence. *Nicotine Tob. Res.* 6, 327–348.
- Stein, M.D., Caviness, C.M., Anderson, B.J., 2014. Alcohol use potentiates marijuana problem severity in young adult women. *Womens Health Issues* 24, 77–82.
- Stinson, F.S., Ruan, W.J., Pickering, R., Grant, B.F., 2006. Cannabis use disorders in the USA Prevalence, correlates and co-morbidity. *Psychol. Med.* 36, 1447–1460.
- Subbaraman, M.S., Kerr, W.C., 2015. Simultaneous versus concurrent use of alcohol and cannabis in the National Alcohol Survey. *Alcohol. Clin. Exp. Res.* 39, 872–879.
- Terry-McElrath, Y.M., O'Malley, P.M., Johnston, L.D., 2013. Simultaneous alcohol and marijuana use among U.S. high school seniors from 1976 to 2011: trends, reasons, and situations. *Drug Alcohol Depend.* 133, 71–79.
- Terry-McElrath, Y.M., O'Malley, P.M., Johnston, L.D., 2014. Alcohol and marijuana use patterns associated with unsafe driving among U.S. high school seniors: high use frequency concurrent use, and simultaneous use. *J. Stud. Alcohol Drugs* 75, 378–389.
- Turner, C.F., Ku, L., Rogers, S.M., Lindberg, L.D., Pleck, J.H., Sonenstein, F.L., 1998. Adolescent sexual behavior, drug use, and violence: increased reporting with computer survey technology. *Science* 280, 867–873.
- Volkow, N.D., Baler, R.D., Compton, W.M., Weiss, S.R., 2014. Adverse health effects of marijuana use. *N. Engl. J. Med.* 370, 2219–2227.
- Zhu, H., Wu, L.T., 2016. Trends and correlates of cannabis-involved emergency department visits: 2004–2011. *J. Addict. Med.* 10, 429–436.