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# Older marijuana users in substance abuse treatment: Treatment settings for marijuana-only versus polysubstance use admissions

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ABSTRACT

*Objective:* Growing numbers of older adult marijuana users make understanding the marijuana-related treatment needs and treatment-related characteristics of this age group increasingly important. In this study, we examined four types of marijuana-involved admissions (marijuana as the only substance; marijuana as the primary substance with other secondary/tertiary substances; marijuana as the secondary substance; and marijuana as the tertiary substance) by treatment setting.

*Methods:* Data came from the 2012–2017 Treatment Episode Data Set-Admissions (TEDS-A), which includes 851,652 admissions by those aged 55+. Using multinomial logistic regression analysis, we focused on the 120,286 marijuana-involved admissions to test the hypothesis that polysubstance use would be associated with a higher likelihood of using detoxification and rehabilitation settings than ambulatory/outpatient settings.

*Results:* Of all marijuana-involved admissions, 7.5% were marijuana-only, 12.7% were marijuana-primary, 58.4% were marijuana-secondary, and 21.4% were marijuana-tertiary admissions. Compared to marijuana-only admissions, admissions involving other substances were associated with a higher likelihood of detoxification and rehabilitation than ambulatory/outpatient treatment (e.g., RRR = 5.79, 95% CI = 5.08–6.61 for detoxification and RRR = 3.19, 95% CI = 2.89–3.52 for rehabilitation among marijuana-tertiary admissions). Referral source, first age of marijuana use, race/ethnicity, and homelessness were significant covariates.

*Conclusions:* Given increasing numbers of older-adult marijuana users, healthcare providers should screen older adults for marijuana and other substance use, and substance abuse treatment programs should become more responsive to older adults' needs.

## 1. Introduction

Marijuana use among older adults has increased. According to the National Survey of Drug Use and Health (NSDUH), from 2002 to 2017, past-year marijuana use rates rose from 2.95% to 10.16% in the 50–64 age group and from 0.15% to 3.70% in the 65+ age group (Han et al., 2017; Salas-Wright et al., 2017; Substance Abuse and Mental Health Services Administration [SAMHSA], 2018). This trend is projected to continue, in part due to aging baby boomers whose attitudes toward psychoactive drug use are more permissive than prior generations and states that have legalized marijuana for medical and/or recreational use (Black & Joseph, 2014; DISA, 2019; Nielsen, 2010). A small fraction of older marijuana users began using in late life, but most first used in adolescence or young adulthood and have used since initiation or stopped using for career and family reasons before reinitiating in late life (Choi, DiNitto, & Marti, 2016). Most medical users also report using recreationally (Choi, DiNitto, & Marti, 2017a).

The National Academies (2017) have identified marijuana's potential therapeutic effects as analgesic and antiemetic (for cancer patients) adjuncts and as sleep aids for individuals with sleep disturbance associated with some chronic conditions. However, these potential health effects found in well-controlled clinical trials should be weighed against the risk for addiction and potential harms due to increased Δ9-THC (tetrahydrocannabinol) concentration over the past decade in commercially and illegally available marijuana products, including unregulated edible products (Chandra et al., 2019; Hasin, 2018; Lamy et al., 2016; Monte et al., 2019). Furthermore, epidemiologic data consistently show that older marijuana users, especially those with marijuana use disorder, have significantly higher rates of alcohol, tobacco, and other illicit drug use and use disorders and mental disorders than nonusers (Choi et al., 2016). Older adults who take multiple prescription and nonprescription drugs along with alcohol and other psychoactive drugs are also at risk for dangerous interaction effects (Blow & Barry, 2012).

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With aging-related physiological changes, polysubstance use among older marijuana users, often comorbid with mental disorders, has significant implications for physical, cognitive, and social functioning; however, treatment rates for older adults are lower than for younger adults (Choi, DiNitto, & Marti, 2014). Only one of five individuals aged 50+ years with lifetime marijuana use disorder received any substance use treatment, though treatment rates were higher for those with other co-occurring substance use disorders (Choi, DiNitto, & Marti, 2017b). The Treatment Episode Data Set-Admissions (TEDS-A), SAMHSA's compilation of admissions to publicly funded treatment programs, shows that while the total number of treatment program admissions for those of all ages has increased only slightly, the proportion of older-adult (aged 55+) admissions increased from 3.4% in 2000 to 7.0% in 2012 (Chhatre, Cook, Mallik, & Jayadevappa, 2017) and to 9.7% in 2017 (SAMHSA, 2019a). Chhatre et al. also found that older-adult admissions with alcohol as the primary substance problem decreased (from 77% in 2002 to 64% in 2012), whereas admissions for cocaine/crack, marijuana/hashish, heroin, non-prescription methadone, other opiates and synthetics, and polysubstance increased. Marijuana was the primary problem substance for 1.2% of admissions aged 55+ years in 2002, 3.0% in 2012 (Chhatre et al., 2017), and 2.7% in 2017 (SAMHSA, 2019a). In addition, the number of admissions with marijuana as the secondary or tertiary problem substance was almost four times more than the number with marijuana as the primary problem substance in 2017, and > 60% of admissions with marijuana as the primary substance included other (secondary) substances (SAMHSA, 2019a).

Although substance use treatment admissions among older adults have increased, no identified studies have examined the characteristics of marijuana-involved treatment admissions. Such an examination may provide information useful in assisting older adults with marijuana-related problems alone or in combination with other substance use problems. In this study based on the 2012–2017 TEDS-A, we examined four types of marijuana-involved admissions (marijuana as the only problem substance; marijuana as the primary substance with other secondary/tertiary substances; marijuana as the secondary substance; and marijuana as the tertiary substance) by treatment setting. Given increasing illicit drug and polysubstance use among older-adult treatment admissions, our hypotheses were: (H1) admissions involving polysubstance use (i.e., with marijuana as the primary substance and other substances as secondary or marijuana as the secondary or tertiary substance) will be associated with a greater likelihood of use of detoxification or inpatient rehabilitation settings than ambulatory/outpatient treatment settings; and (H2) among admissions involving marijuana as the primary substance with other substances as secondary, those involving illicit drugs rather than alcohol will be associated with a higher likelihood of use of detoxification or inpatient rehabilitation settings than ambulatory/outpatient treatment settings. Covariates were referral source, 30-day arrest history, prior treatment history, first age of marijuana use, psychiatric problems, admission year, and demographics. The findings will increase knowledge about older marijuana users, especially polysubstance users, who entered treatment either voluntarily or involuntarily, and their treatment-related characteristics.

## 2. Material and methods

### 2.1. Data and sample

TEDS-A includes treatment admissions of those aged 12+ to facilities that are licensed or certified by a state substance abuse agency and receive state alcohol and/or drug agency funds (including federal block grant funds to provide care for people with a substance use disorder) or facilities that are administratively tracked for other reasons (SAMHSA, 2019b). We included 2012–2017 data since 2012 was the year Colorado and Washington became the first states to approve adult-use recreational marijuana measures, followed by Alaska, Oregon, and the District of Columbia in 2014 and California, Maine, Massachusetts, and Nevada in late 2016. A few states have not participated in TEDS-A every year. South Carolina did not participate in 2014, Oregon and South Carolina in 2015, and Georgia and Oregon in 2016 and 2017.

Each TEDS record represents a treatment episode (e.g., an individual admitted to treatment twice within a calendar year is counted as two admissions). Between 2012 and 2017, a total of 10,289,257 admissions (1,749,767 in 2012; 1,683,451 in 2013; 1,614,358 in 2014; 1,537,025 in 2015; 1,699,261 in 2016; and 2,005,395 in 2017) were recorded. Of these, 8.3% or 851,652 admissions (121,015 in 2012; 125,287 in 2013; 128,415 in 2014; 132,273 in 2015; and 150,511 in 2016; and 200,913 in 2017) were of those aged 55+. Of all admissions aged 55+, 85.9% (n = 731,366) did not include marijuana/hashish (marijuana hereafter), 2.8% (n = 24,328) had marijuana as the primary substance, with or without a secondary substance, and 11.3% (n = 95,958) included marijuana as the secondary or tertiary substance. In this study, we first compared these three groups of admissions (no marijuana, marijuana as the primary substance, and marijuana as the secondary or tertiary substance) among those aged 55+ with respect to referral source, service setting, and demographics. Then, we focused on the 120,286 marijuana-involved admissions to test study hypotheses.

### 2.2. Measures

#### 2.2.1. Type of marijuana-involved admissions

For all admissions, TEDS-A lists primary, secondary, and tertiary problem substances. In this study, we used alcohol, cocaine/crack, marijuana, methamphetamine/amphetamine (and other stimulants), heroin, other opiates (nonprescription methadone, other opiates and synthetics), and due to their small proportions, we included hallucinogens, benzodiazepines/other tranquilizers, barbiturates/other sedatives/hypnotics, inhalants, over-the-counter medications, and other as "other" drugs/substances. Of all marijuana-involved admissions, we distinguished the following four categories: (1) marijuana was the only problem substance (marijuana-only); (2) marijuana was the primary problem substance with one or more other substances as secondary problems (marijuana-primary); (3) marijuana was secondary to alcohol or other substances (marijuana-secondary); and (4) marijuana was tertiary to alcohol and/or other substances (marijuana-tertiary).

#### 2.2.2. Treatment setting at admission

TEDS-A included the following settings: ambulatory, nonintensive outpatient; ambulatory, intensive outpatient; ambulatory detoxification; 24-hour inpatient hospital or free-standing, residential detoxification; short-term (≤30 days) residential rehabilitation; and long-term (> 30 days) residential rehabilitation. For multivariable regression analysis, we grouped these settings into three: ambulatory/outpatient treatment; detoxification; and residential rehabilitation.

#### 2.2.3. Treatment referral sources

These sources were self or other individual (family member, friend, or other individual); alcohol/drug abuse care provider; other healthcare provider (physician, psychiatrist, or other licensed health care professional, general hospital, psychiatric hospital, mental health program, or nursing home); employer/employee assistance program (EAP); school; other community entity (including social service and religious organizations and self-help groups); court/criminal justice referral/DUI (driving under the influence). In this study, we combined employer/EAP, school, and other community entity into a single group.

#### 2.2.4. Number of previous treatment episodes

This referred to the number of previous drug and/or alcohol treatment episodes for the individual admitted to treatment (0 to 5+ times).

#### 2.2.5. Number of arrests in the 30 days prior to admission

We coded these as 0 and 1+ times.

#### 2.2.6. First age of marijuana use

We coded this as ≤14, 15–17, 18–20, 21–29, and ≥30 years.

#### 2.2.7. Past-month marijuana use frequency

We reported this (no, some, and daily use) for descriptive purposes only.

#### 2.2.8. Psychiatric problem

Presence of a psychiatric problem in addition to alcohol/drug use was coded as yes, no, or missing (SAMHSA, 2019b).

#### 2.2.9. Demographics

These variables were gender; race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, American Indian/Alaska Native; Asian/Pacific Islander, Other/Multi-racial); living arrangement (independent living [living alone or with others without supervision, dependent living], living in a supervised setting, homeless [no fixed address or living at a shelter]); education (< 12 years, 12 years, 13–15 years, 16+ years, missing); and census region (Northeast, Midwest, Southwest, West, US jurisdiction/territory).

### 2.3. Analysis

All analyses were conducted with Stata 15/MP. First, we described proportions of marijuana-involved admissions among all admissions aged 55+ and 95% confidence intervals (CIs) by admission year and the composition (n, %) of these admissions (marijuana-only, marijuana as the primary substance with other substances as secondary, marijuana as the secondary substance, and marijuana as the tertiary substance). Second, using proportions and 95% CIs, we compared marijuana-only or -primary admissions and marijuana-secondary or -tertiary admissions to admissions without marijuana with respect to admission year, treatment setting, referral source, previous treatment episode(s), and demographics. Third, we focused on marijuana-involved admissions and used $\chi^2$ tests to compare treatment-related and other clinical characteristics and demographics among marijuana-only, marijuana-primary, marijuana-secondary, and marijuana-tertiary admissions. Fourth, to test hypothesis 1, we used multinomial logistic regression with treatment setting (detoxification and residential rehabilitation compared to ambulatory/outpatient setting) as the dependent variable and type of marijuana involvement (marijuana-only [reference category], marijuana-primary, marijuana-secondary, and marijuana-tertiary) as the independent variable. To test hypothesis 2, we also used multinomial logistic regression with treatment setting as the dependent variable and type of secondary substance (alcohol [reference category], cocaine/crack, methamphetamine/amphetamine, heroin, other opiates, and other drugs) as the independent variable. Variance inflation factor diagnostics, using a cut-off of 2.50 (Allison, 2015), showed that multicollinearity among the independent variables and covariates (listed in the measures section) was not a concern. Multinomial logistic regression results are presented as relative risk ratios (RRR) with 95% CI.

## 3. Results

### 3.1. Proportions of marijuana-involved admissions aged 55+ by admission year

Table 1 shows that during the study period (2012–2017), 14.1% of all admissions aged 55+ involved marijuana. The proportions and 95% CIs show some fluctuations: an increase in the proportion in 2014 compared to 2012 and 2013, then a decrease in 2015, an increase in 2016, and then a decrease in 2017. Notwithstanding the proportional fluctuations, the absolute number of marijuana-involved admissions increased by > 150% between 2012 and 2017, reflecting the marked (166%) increase in all admissions aged 55+ during the same time period. Of all marijuana-involved admissions, marijuana-only admissions steadily declined from 8.6% (95% CI = 8.2–9.0) in 2012 to 6.2% (95% CI = 5.9–6.5) in 2017. The proportions of admissions with marijuana as the primary substance with other substances as secondary (12.7%), marijuana as the secondary substance (58.4%), and marijuana as the tertiary substance (21.4%) did not change significantly; however, the numbers of admissions in these three categories increased significantly (163% for marijuana-primary, 157% for marijuana-secondary, and 155% for marijuana-tertiary admissions between 2012 and 2017).

### 3.2. Comparisons of non-marijuana-involved and marijuana-involved admissions

Table 2 shows that compared to admissions without marijuana, marijuana-only or -primary admissions had a significantly higher rate (nearly 85%) of admissions to ambulatory/outpatient treatment settings. Compared to admissions without marijuana, marijuana-involved admissions overall, and marijuana-only or -primary admissions in particular, had lower rates of referrals by self or other individuals and substance abuse care providers but higher rates of referrals by employer/EAP/community entities and courts/criminal justice systems/DUI. Although there are high rates of missing data on prior treatment episode, the available data indicate that marijuana-only or -primary admissions had the lowest rate of previous treatment, while marijuana-tertiary admissions had the highest rate. Marijuana-involved admissions also included a higher rate of non-Hispanic Blacks and a lower rate of those with college education.

### 3.3. Characteristics of marijuana-involved admissions

Table 3 shows that in 51% of marijuana-primary admissions, alcohol was the secondary substance, followed by cocaine/crack (19%), methamphetamines/amphetamines (13%), and heroin or other opiates (7%). In 67% of marijuana-secondary admissions, alcohol was the primary substance, followed by cocaine/crack (11%), heroin (10%), methamphetamines/amphetamines (7%), and other opiates (3%). In 48% of marijuana-tertiary admissions, alcohol was the primary substance, followed by heroin (23%), cocaine/crack (18%), other opiates (6%), and methamphetamines/amphetamines (4%). Additional analysis showed that among all marijuana-involved admissions aged 55+ between 2012 and 2017, alcohol as a problem substance decreased from 70% to 62%; however, cocaine/crack did not change (31% to 30%) and heroin and methamphetamine increased from 12% to 15% and from 6% to 12%, respectively.

Over 90% of marijuana-only admissions were to ambulatory/outpatient settings, and the corresponding percentages were 82%, 63%, and 57% for marijuana-primary, marijuana-secondary, and marijuana-tertiary admissions, respectively. Marijuana-only and -primary admissions had significantly lower rates of detoxification and residential rehabilitation use than marijuana-secondary and -tertiary admissions.

Marijuana-only and -primary admissions also differed from marijuana-secondary and -tertiary admissions on referral sources. Less than 30% of referrals for marijuana-only and -primary admissions came from self or other individuals, compared to 39% for marijuana-secondary and 44% for marijuana-tertiary admissions. Over 40% of referrals for marijuana-only and -primary admissions came from court/criminal justice systems/DUI compared to 28% for marijuana secondary and 20% for marijuana tertiary admissions. The share of DUI referrals in the court/criminal justice systems/DUI category were the highest (17%) among marijuana-secondary admissions. With regard to previous treatment, 58% of marijuana-only admissions had none, followed by 39% of marijuana-primary, 27% of marijuana-secondary, and 18% of marijuana-tertiary admissions.

**Table 1**
Marijuana-involved TEDS admissions aged 55+, 2012–2017.

| Admission year | All marijuana-involved admissions | | Of all marijuana-involved admissions | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Marijuana-only | | Marijuana-primary with other secondary substance | | Marijuana-secondary | | Marijuana-tertiary | |
| | N | % (95% CI) | N | % | N | % | N | % | N | % |
| 2012 | 17,022 | 14.1 (13.9–14.3) | 1458 | 8.6 | 2164 | 12.7 | 9789 | 57.5 | 3611 | 21.2 |
| 2013 | 18,009 | 14.4 (14.2–14.6) | 1549 | 8.6 | 2223 | 12.3 | 10,505 | 58.3 | 3732 | 20.7 |
| 2014 | 19,063 | 14.8 (14.7–15.0) | 1508 | 7.9 | 2391 | 12.5 | 11,043 | 57.9 | 4121 | 21.6 |
| 2015 | 18,274 | 13.8 (13.6–14.0) | 1367 | 7.5 | 2236 | 12.2 | 10,754 | 58.9 | 3917 | 21.6 |
| 2016 | 21,856 | 14.5 (14.3–14.7) | 1506 | 6.9 | 2777 | 12.7 | 12,861 | 58.8 | 4712 | 21.6 |
| 2017 | 26,062 | 13.4 (13.3–13.6) | 1618 | 6.2 | 3531 | 13.6 | 15,327 | 58.8 | 5586 | 21.4 |
| 2012–2017 | 120,286 | 14.1 (14.1–14.2) | 9006 | 7.5 | 15,322 | 12.7 | 70,279 | 58.4 | 25,679 | 21.4 |

CI = Confidence interval.

**Table 2**
TEDS admissions aged 55+ with or without marijuana as a substance of abuse: Admission year, treatment settings, referral sources, and demographics (column % with 95% confidence intervals).

| | All admissions aged 55+ (N = 851,652) | | |
|---|---|---|---|
| | Marijuana not substance of abuse | Marijuana-only or -primary admissions | Marijuana-secondary or -tertiary admissions |
| N (%) | 731,366 (85.9%) | 24,328 (2.8%) | 95,958 (11.3%) |
| Treatment setting at admission | | | |
| Ambulatory, nonintensive outpatient | 42.8 (42.7–42.9) | 71.1 (71.1–72.2) | 48.5 (48.2–48.8) |
| Ambulatory, intensive outpatient | 9.0 (8.9–9.1) | 13.5 (13.1–13.9) | 12.6 (12.4–12.8) |
| Detox, ambulatory, hospital inpatient, or free-standing residential | 33.0 (32.9–33.1) | 5.2 (4.9–5.5) | 20.3 (20.2–20.7) |
| Residential rehab ≤30 days/nonspecified | 9.5 (9.4–9.6) | 5.3 (5.0–5.6) | 11.4 (11.2–11.6) |
| Residential rehab > 30 days | 5.6 (5.6–5.7) | 4.4 (4.1–4.7) | 7.0 (6.9–7.2) |
| Referral source | | | |
| Self or other individual | 47.7 (47.5–47.8) | 26.7 (26.1–27.2) | 39.9 (39.6–40.2) |
| Substance use care provider | 10.3 (10.2–10.4) | 4.7 (4.4–5.0) | 10.6 (10.4–10.8) |
| Other healthcare provider | 9.7 (9.6–9.7) | 9.3 (8.9–9.6) | 9.5 (9.3–9.7) |
| Employer/EAP/other community entity | 10.5 (10.5–10.6) | 15.2 (14.8–15.7) | 11.6 (11.4–11.8) |
| Court/criminal justice system/DUI | 19.3 (19.2–19.4) | 41.2 (40.6–41.8) | 25.6 (25.4–25.9) |
| Missing | 2.6 (2.6–2.6) | 3.0 (2.8–3.2) | 2.8 (2.7–2.9) |
| No. of prior treatment episodes | | | |
| None | 27.7 (27.6–27.8) | 45.8 (45.2–46.4) | 24.9 (24.6–25.1) |
| 1–5 times | 57.6 (57.4–57.7) | 47.1 (46.5–47.7) | 62.4 (62.1–62.7) |
| Missing | 14.8 (14.7–14.8) | 7.1 (6.8–7.4) | 12.7 (12.5–12.9) |
| Male | 73.3 (73.2–73.4) | 75.7 (75.1–76.2) | 78.7 (78.4–78.9) |
| Race/ethnicity | | | |
| Non-Hispanic White | 54.2 (54.1–54.3) | 51.4 (50.7–52.0) | 50.6 (50.3–50.9) |
| Non-Hispanic Black | 27.3 (27.2–27.4) | 33.6 (33.0–34.2) | 33.3 (33.0–33.6) |
| Hispanic | 12.0 (11.9–12.1) | 8.9 (8.6–9.3) | 9.5 (9.4–9.7) |
| American Indian/Alaska Native | 1.7 (1.7–1.7) | 1.7 (1.5–1.8) | 2.1 (2.0–2.2) |
| Asian/Pacific Islander | 0.7 (0.6–0.7) | 0.7 (0.6–0.8) | 0.5 (0.5–0.6) |
| Other/multi-race | 2.3 (2.3–2.4) | 2.0 (1.9–2.2) | 2.1 (2.0–2.2) |
| Missing | 1.8 (1.8–1.9) | 1.7 (1.6–1.9) | 1.9 (1.8–2.0) |
| Education > 16 years | 11.3 (11.3–11.4) | 6.9 (6.6–7.2) | 7.8 (7.6–7.9) |

EAP = employee assistance program.
Pearson $\chi^2$ tests were used to compare differences between two groups. All differences were significant at $p < 0.001$.

More than three-quarters of all marijuana-involved admissions were men, but the proportion of men was lowest among marijuana-only admissions. Non-Hispanic Blacks were 28% of marijuana-secondary admissions but they were 47% of marijuana-tertiary admissions. The distribution of other racial/ethnic minority groups did not differ significantly across marijuana admission types. Marijuana-secondary and -tertiary admissions also contained higher proportions of homeless people than the other two admissions groups. Marijuana-secondary admissions had the highest proportion of college-educated people, and marijuana-tertiary admissions were most likely in the Northeast and least likely in the West.

### 3.4. First age of marijuana use, past-month use, and psychiatric problems

Table 4 shows that 56% of marijuana-only, 67% of marijuana-primary, 61% of marijuana-secondary, and 54% of marijuana-tertiary admissions first used marijuana at age 17 or younger. In terms of use frequency, 23% of marijuana-only, 27% of marijuana-primary, 34% of marijuana-secondary, and 42% of marijuana-tertiary admissions were daily users. Given the high rate of missing data, proportions of those with psychiatric problems were likely to be underestimates, but the 31% to 36% rates across the four admissions groups based on available data are higher than the general population.

### 3.5. Association of treatment setting with type of marijuana involvement among all marijuana admissions and with secondary substances among marijuana-primary admissions

The second and third columns of Table 5 show that compared to marijuana-only admissions, marijuana-primary admissions had a 1.24

**Table 3**
Marijuana-involved admissions: Treatment setting, other substance use, referral source, treatment history, and demographics (column %).

| | All marijuana-involved admissions aged 55+ (n = 120,286) | | | |
|---|---|---|---|---|
| | Marijuana-only | Marijuana-primary | Marijuana- secondary | Marijuana- tertiary |
| N (%) | 9006 (7.5%) | 15,322 (12.7%) | 70,279 (58.4%) | 25,679 (21.4%) |
| Secondary substance for marijuana primary | | | | |
| Alcohol | 0 | 51.0 | | |
| Cocaine/crack | 0 | 19.2 | | |
| Methamphetamine/amphetamine | 0 | 12.7 | | |
| Heroin | 0 | 3.6 | | |
| Other opiates | 0 | 3.7 | | |
| Other drug | 0 | 9.8 | | |
| Primary substance for marijuana secondary or tertiary | | | | |
| Alcohol | | | 67.4 | 47.5 |
| Cocaine/crack | | | 11.2 | 18.3 |
| Methamphetamine/amphetamine | | | 7.4 | 4.2 |
| Heroin | | | 10.2 | 22.7 |
| Other opiates | | | 3.1 | 5.6 |
| Other drug | | | 0.8 | 1.7 |
| Treatment setting at admission | | | | |
| Ambulatory nonintensive outpatient | 80.0 | 66.8 | 49.7 | 45.1 |
| Ambulatory intensive outpatient | 10.6 | 15.2 | 13.0 | 11.5 |
| Detox, ambulatory, hospital inpatient or free-standing residential | 3.4 | 6.3 | 19.5 | 22.9 |
| Residential rehab ≤30 days | 3.7 | 6.2 | 10.3 | 14.6 |
| Residential rehab > 30 days | 2.4 | 5.6 | 7.5 | 5.9 |
| Referral source | | | | |
| Self or other individual | 27.2 | 26.4 | 38.6 | 43.5 |
| Substance use care provider | 3.4 | 5.4 | 9.7 | 12.8 |
| Other healthcare provider | 9.4 | 9.2 | 9.6 | 9.3 |
| Employer/EAP/other community entity | 15.2 | 15.2 | 11.4 | 12.1 |
| Court/criminal justice system/DUI | 41.7 | 40.9 | 27.9 | 19.5 |
| Missing | 3.1 | 2.9 | 2.8 | 2.7 |
| DUI within all court/criminal justice/DUI referrals | 4.0 | 6.7 | 17.0 | 7.9 |
| Arrested 1+ times within 30 days prior to admission | 6.8 | 13.5 | 16.8 | 18.8 |
| Previous treatment episodes | | | | |
| None | 58.0 | 38.6 | 27.4 | 17.9 |
| One | 21.1 | 22.4 | 19.8 | 16.1 |
| Two | 7.2 | 12.0 | 12.2 | 12.4 |
| Three | 3.3 | 6.7 | 8.1 | 9.3 |
| Four | 1.6 | 3.6 | 4.8 | 5.7 |
| Five or more | 3.1 | 8.8 | 16.2 | 22.6 |
| Missing | 5.6 | 8.0 | 11.6 | 15.9 |
| Demographics | | | | |
| % male | 73.2 | 77.1 | 78.9 | 78.0 |
| Race/ethnicity | | | | |
| Non-Hispanic White | 52.9 | 50.4 | 55.4 | 37.4 |
| Non-Hispanic Black | 32.8 | 34.1 | 28.3 | 46.8 |
| Hispanic | 8.8 | 9.0 | 9.2 | 10.6 |
| American Indian/Alaska Native | 1.4 | 1.8 | 2.4 | 1.4 |
| Asian/Pacific Islander | 0.7 | 0.7 | 0.6 | 0.4 |
| Other/multi race | 1.7 | 2.2 | 2.1 | 2.0 |
| Missing | 1.6 | 1.8 | 2.1 | 1.3 |
| Living arrangement | | | | |
| Independent living | 77.8 | 69.1 | 64.6 | 64.3 |
| Dependent living | 11.6 | 13.6 | 12.8 | 11.8 |
| Homeless | 8.5 | 14.1 | 19.6 | 21.0 |
| Missing | 2.2 | 3.2 | 3.0 | 2.9 |
| Education | | | | |
| < 12 years | 27.3 | 27.6 | 25.3 | 30.2 |
| 12 years | 42.8 | 42.4 | 42.0 | 40.2 |
| 13–15 years | 19.9 | 19.8 | 21.3 | 20.2 |
| 16+ years | 7.0 | 6.8 | 8.3 | 6.4 |
| Missing | 3.0 | 3.4 | 3.1 | 3.0 |
| Census region | | | | |
| Northeast | 29.6 | 31.6 | 35.3 | 47.7 |
| Midwest | 18.6 | 20.6 | 19.7 | 17.1 |
| Southwest | 28.0 | 20.3 | 16.7 | 21.3 |
| West | 23.8 | 27.3 | 28.2 | 13.7 |
| US jurisdiction/territory | 0.1 | 0.2 | 0.1 | 0.2 |

Note: Pearson $\chi^2$ tests were used to compare differences among the four groups. All differences were significant at $p < 0.001$.

times (95% CI = 1.07–1.44) higher likelihood of detoxification admission and a 1.79 times (CI = 1.61–1.99) higher likelihood of rehabilitation than ambulatory/outpatient treatment admission. Marijuana-secondary admissions had a 4.75 times (95% CI = 4.18–5.40) higher likelihood of detoxification admission and a 2.97 times (95% CI = 2.70–3.27) higher likelihood of residential rehabilitation admission. Marijuana-tertiary admissions had a 5.79 times (95% CI = 5.08–6.61) higher likelihood of detoxification admission and a

**Table 4**
Age of first marijuana use, past-month use, and psychiatric problem (column %).

| | All marijuana-involved admissions aged 55+ (n = 120,286) | | | |
|---|---|---|---|---|
| | Marijuana-only | Marijuana-primary | Marijuana-only | Marijuana-tertiary |
| N (%) | 9006 (7.5%) | 15,322 (12.7%) | 70,279 (58.4%) | 25,679 (21.4%) |
| Age of first marijuana use | | | | |
| ≤14 | 24.3 | 33.1 | 30.8 | 28.4 |
| 15–17 | 32.2 | 33.4 | 29.7 | 25.4 |
| 18–20 | 21.0 | 17.1 | 15.6 | 14.4 |
| 21–29 | 11.7 | 9.4 | 10.3 | 12.1 |
| 30+ | 9.8 | 5.8 | 12.8 | 18.7 |
| Missing | 1.1 | 1.1 | 0.9 | 1.0 |
| Past month use frequency | | | | |
| None | 38.5 | 34.9 | 28.9 | 26.7 |
| Some | 37.9 | 37.9 | 36.8 | 30.6 |
| Daily | 22.8 | 26.5 | 33.5 | 41.6 |
| Missing | 0.9 | 0.8 | 0.9 | 1.1 |
| Psychiatric problem | | | | |
| Yes | 30.5 | 33.9 | 31.4 | 35.7 |
| No | 52.7 | 47.0 | 45.9 | 37.9 |
| Missing | 16.8 | 19.1 | 22.7 | 26.4 |

Note: Pearson $\chi^2$ tests were used to compare differences among the four groups. All differences were significant at $p < 0.001$.

3.19 times (95% CI = 2.89–3.52) higher likelihood of residential rehabilitation than ambulatory/outpatient treatment admission.

The fifth column of Table 5 further examines marijuana-primary with other secondary substance admissions. Compared to admissions with alcohol as the secondary substance, the likelihood of residential rehabilitation was 1.29 times (95% CI = 1.11–1.47) higher than ambulatory/outpatient when cocaine/crack was the secondary substance and 1.74 times (95% CI = 1.46–2.07) higher when methamphetamine/amphetamine was the secondary substance.

Of the covariates, referrals from substance use care providers, as opposed to self and other individual referrals, were significantly more likely to result in residential rehabilitation admission, whereas employers/EAP/other community referrals and court/criminal justice/DUI referrals were significantly less likely to result in detoxification and residential rehabilitation admissions in both regression models. Referrals from healthcare providers were also more likely to result in residential rehabilitation among all marijuana-involved admissions. Arrest history was associated with a higher likelihood of detoxification admission, and prior treatment history was associated with a higher likelihood of both detoxification and rehabilitation admissions in both regression models. Compared to those who first used at age 30+, younger first-use ages (≤20 years) were associated with a higher likelihood of detoxification among all admissions, while those who first used at age < 14 had a higher likelihood and those who first used at ages 15–29 had a lower likelihood of residential rehabilitation. The findings also show that compared to 2012 admissions, 2015 and 2016 admissions had a higher likelihood of detoxification or residential rehabilitation, and 2017 admissions had a lower likelihood of detoxification in both models but higher likelihood of residential rehabilitation among all admissions. Racial/ethnic minorities and homeless people tended to have a higher likelihood of detoxification and residential rehabilitation admissions in both models. Regional differences suggest detoxification admissions were more likely in the West than the Northwest.

## 4. Discussion and conclusions

Findings show that the number of older-adult admissions for substance use treatment increased steadily from 2012 to 2017, totaling nearly 852,000 during the six years of observation. One of seven older-adult admissions included marijuana as a problem substance. Marijuana was the sole substance in 7.5% of all marijuana-involved admissions, while 92.5% of marijuana-involved admissions included other substances confirming a high rate of polysubstance use among older marijuana users who entered treatment. Thus, the study findings largely stem from polysubstance use among most older adult marijuana users. Our findings also show that the proportion of marijuana-only admissions steadily declined from nearly 9% in 2012 to 6% in 2017. Research is needed to examine whether marijuana legalization has influenced decreased treatment-seeking among older adults who use marijuana only. Overall, high polysubstance use rates among older adult marijuana users appear to be similar to those among younger adults. An epidemiologic study found that 81% of those aged 18+ with lifetime marijuana use disorder also had at least one other lifetime substance use disorder (McCabe, West, Jutkiewicz, & Boyd, 2017). The study also found that those with than those without multiple substance use disorders had a more persistent pattern of polysubstance use over time and were less likely to remit (McCabe et al., 2017), suggesting greater substance use problem severity, adverse consequences, and need for treatment.

As expected, alcohol was the most common substance involved in treatment admissions in combination with marijuana, but illicit drugs, including cocaine/crack, heroin/other opiates, and/or methamphetamines/amphetamines, were also found in a significant proportion of marijuana-involved admissions. The significantly higher likelihood of detoxification and residential rehabilitation use among polysubstance-involved admissions compared to marijuana-only admissions (supporting H1) also points to greater adverse effects from polysubstance use, whether it involves alcohol and/or illicit drugs, that necessitate greater use of inpatient/residential treatment than ambulatory/outpatient care. In marijuana-primary admissions, cocaine/crack, methamphetamines/amphetamines, or "other" drugs compared to alcohol as a secondary problem substance were associated with a higher likelihood of residential rehabilitation admission (partially supporting H2).

With regard to demographic characteristics, even after controlling for types of marijuana-involved admissions, racial/ethnic minorities were significantly more likely to enter detoxification and residential rehabilitation than ambulatory/outpatient services, suggesting greater severity of substance use and medical problems. Older adults in residential treatment tend to have more medical problems than their younger counterparts (Morse, Watson, MacMaster, & Bride, 2015), and minority older adults are likely to experience worse health problems given their generally lower socioeconomic status. Homeless people are also likely to experience worse health problems, and older homeless people with substance use problems are likely to need comprehensive healthcare, housing, and social services.

Of all marijuana-involved admissions, a large portion of those with polysubstance use had prior treatment episodes. More than one in six marijuana-secondary and more than one in five marijuana-tertiary admissions had 5+ prior treatment episodes. Although data on when they received treatment and whether they completed treatment were not available, multiple treatment episodes indicate chronic substance use disorders among a significant proportion of marijuana-involved admissions. If the co-use of marijuana and illicit drugs continues to increase in the future, the need for detoxification and rehabilitation will also increase. The proportion of first-time treatment admissions was also large, i.e., 58% of marijuana-only and 39% of marijuana-primary admissions had no prior treatment episode. A previous study based on the 1998–2008 TEDS-A found that among older-adult admissions, the proportion of first time admissions was greater than that among younger adult admissions (Arndt, Clayton, & Schultz, 2011).

**Table 5**
Association of treatment setting with type of marijuana-involved admission and other substance use.

| | All marijuana-involved admissions | | Marijuana-primary with other substance admissions only | |
|---|---|---|---|---|
| | Compared to ambulatory/outpatient treatment | | Compared to ambulatory/outpatient treatment | |
| | Detoxification RRR (95% CI) | Residential rehabilitation RRR (95% CI) | Detoxification RRR (95% CI) | Residential rehabilitation RRR (95% CI) |
| Type of marijuana admission: Marijuana only vs. | | | | |
| Marijuana-primary | 1.24 (1.07–1.44)** | 1.79 (1.61–1.99)*** | | |
| Marijuana-secondary | 4.75 (4.18–5.40)*** | 2.97 (2.70–3.27)*** | | |
| Marijuana-tertiary | 5.79 (5.08–6.61)*** | 3.19 (2.89–3.52)*** | | |
| Secondary substance: Alcohol vs. | | | | |
| Cocaine/crack | | | 0.89 (0.70–1.11) | 1.28 (1.11–1.47)** |
| Methamphetamine | | | 0.87 (0.65–1.17) | 1.74 (1.46–2.07)*** |
| Heroin | | | 1.00 (0.67–1.48) | 1.05 (0.79–1.39) |
| Other opiates | | | 1.52 (0.99–2.32) | 1.30 (0.97–1.75) |
| Other substances | | | 1.34 (0.97–1.84) | 0.81 (0.64–1.02) |
| Referral source: Self or other individual vs. | | | | |
| Substance use care provider | 0.80 (0.75–0.86)*** | 3.07 (2.91–3.23)*** | 1.29 (0.94–1.77) | 3.34 (2.76–4.03)*** |
| Other healthcare provider | 0.91 (0.86–0.97)** | 1.15 (1.08–1.22)*** | 0.78 (0.59–1.04) | 0.91 (0.75–1.10) |
| Employer/EAP/other community entity | 0.47 (0.44–0.50)*** | 0.71 (0.69–0.75)*** | 0.33 (0.25–0.43)*** | 0.50 (0.41–0.60)*** |
| Court/criminal justice/DUI | 0.16 (0.15–0.17)*** | 0.45 (0.43–0.47)*** | 0.16 (0.12–0.20)*** | 0.45 (0.39–0.52)*** |
| Missing | 0.33 (0.29–0.38)*** | 0.66 (0.58–0.76)*** | 1.15 (0.78–1.70) | 0.64 (0.42–0.97)* |
| Arrested 1+ times in past 30 days vs. not arrested | 5.07 (4.82–5.33)*** | 1.14 (1.08–1.21)*** | 5.94 (4.89–7.21)*** | 1.15 (0.95–1.38) |
| At least one prior treatment episode vs. none | 1.67 (1.59–1.75)*** | 1.47 (1.41–1.54)*** | 2.24 (1.83–2.75)*** | 1.63 (1.44–1.85)*** |
| Age of first marijuana use: 30+ years vs. | | | | |
| ≤14 | 1.67 (1.56–1.78)*** | 1.13 (1.07–1.19)*** | 0.60 (0.42–0.85)** | 1.21 (0.93–1.56) |
| 15–17 | 1.36 (1.28–1.45)*** | 0.94 (0.89–0.99)* | 0.69 (0.49–0.97)* | 0.99 (0.76–1.28) |
| 18–20 | 1.18 (1.10–1.27)*** | 0.85 (0.79–0.90)*** | 0.55 (0.37–0.80)** | 0.83 (0.62–1.09) |
| 21–29 | 0.98 (0.91–1.07) | 0.85 (0.79–0.91)*** | 0.70 (0.47–1.05) | 0.83 (0.61–1.13) |
| Psychiatric problems: no vs. | | | | |
| Yes | 0.67 (0.64–0.70)*** | 1.07 (1.03–1.11)** | 0.54 (0.42–0.85)*** | 1.05 (0.93–1.19) |
| Missing | 2.74 (2.61–2.88)*** | 1.33 (1.27–1.41)*** | 3.28 (2.66–4.04)*** | 1.44 (1.22–1.69)*** |
| Admission year: 2012 vs. | | | | |
| 2013 | 1.04 (0.97–1.12) | 1.01 (0.95–1.08) | 0.93 (0.69–1.25) | 0.96 (0.78–1.18) |
| 2014 | 1.03 (0.96–1.10) | 1.00 (0.94–1.07) | 0.89 (0.67–1.20) | 0.99 (0.80–1.21) |
| 2015 | 1.21 (1.13–1.30)*** | 1.16 (1.08–1.23)*** | 1.08 (0.80–1.46) | 1.27 (1.04–1.54)* |
| 2016 | 1.00 (0.94–1.07) | 1.17 (1.10–1.25)*** | 1.21 (0.90–1.61) | 1.04 (0.86–1.27) |
| 2017 | 0.81 (0.76–0.86)*** | 1.22 (1.15–1.30)*** | 0.71 (0.53–0.95)* | 1.08 (0.89–1.30) |
| Male (vs. female) | 1.38 (1.32–1.45)*** | 1.11 (1.06–1.15)*** | 1.44 (1.16–1.79)** | 1.05 (0.92–1.21) |
| Race/ethnicity: Non-Hispanic White vs. | | | | |
| Non-Hispanic Black | 1.17 (1.12–1.23)*** | 1.26 (1.21–1.32)*** | 1.43 (1.17–1.76)** | 1.48 (1.29–1.69)*** |
| Hispanic | 1.12 (1.05–1.20)** | 0.99 (0.92–1.05) | 1.26 (0.94–1.70) | 1.53 (1.26–1.86)*** |
| All other | 1.47 (1.36–1.58)*** | 1.22 (1.14–1.31)*** | 0.85 (0.59–1.22) | 1.35 (1.08–1.69)** |
| Education: <12 years vs. | | | | |
| 12 years | 1.22 (1.16–1.23)*** | 0.96 (0.92–0.99)* | 1.25 (1.02–1.53)* | 0.96 (0.84–1.09) |
| 13–15 years | 1.12 (1.05–1.20)** | 1.06 (1.01–1.12)* | 1.28 (1.00–1.64)* | 1.08 (0.92–1.26) |
| 16+ years | 1.08 (0.99–1.17) | 1.04 (0.97–1.11) | 1.18 (0.82–1.69) | 1.11 (0.88–1.40) |
| Missing | 1.07 (0.92–1.25) | 0.68 (0.58–0.79)*** | 1.35 (0.74–2.45) | 0.57 (0.34–0.97)* |
| Living arrangement: Independent living vs. | | | | |
| Dependent living | 0.85 (0.79–0.91)*** | 2.25 (2.15–2.36)*** | 1.03 (0.78–1.37) | 2.87 (2.50–3.31)*** |
| Homeless | 5.19 (4.96–5.43)*** | 4.39 (4.20–4.58)*** | 4.00 (3.31–4.85)*** | 4.28 (3.74–4.90)*** |
| Region: Northeast vs. | | | | |
| Midwest | 0.79 (0.75–0.84)*** | 0.93 (0.88–0.98)** | 0.44 (0.33–0.59)*** | 0.97 (0.82–1.14) |
| South | 0.97 (0.91–1.03) | 1.02 (0.97–1.07) | 0.52 (0.40–0.68)*** | 1.07 (0.90–1.26) |
| West | 2.06 (1.96–2.18)*** | 0.90 (0.85–0.94)*** | 1.42 (1.13–1.78)** | 0.93 (0.79–1.09) |
| Model statistics | N = 115,555 admissions; likelihood ratio $\chi^2$ = 45,039.13, $p < 0.001$, Pseudo $R^2$ = 0.222 | | N = 14,411 admissions; likelihood ratio $\chi^2$ = 3407.95, $p < 0.001$, Pseudo $R^2$ = 0.204 | |

Note: Admissions in US jurisdictions/territories were excluded due to small numbers.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

Another important finding is that self or other individuals were the most prevalent referral sources for marijuana-secondary and-tertiary admissions. This suggests that older adults themselves or family/friends were aware of these substance use problems, probably because these older adults had problems with substances (e.g., alcohol, cocaine/crack, heroin/other opiates) that may have caused them more harm than marijuana. In contrast, courts/criminal justice systems/DUI were the most prevalent referral sources for marijuana-only and -primary admissions. These older adults may have been less willing to seek treatment voluntarily or to perceive that their problems are marijuana

related. Those caught using marijuana in states where marijuana is illegal may have been prompted to enter treatment because they faced criminal charges. Marijuana-only admissions in particular may have included those who did not see harms from using marijuana, especially since they were not using other substances. However, 42% of marijuana-only admissions had prior treatment, suggesting that they may have had problems with marijuana and/or other substance use in the past or were using marijuana as a substitute for drugs they had previously used that are considered more harmful. Criminal justice referrals also indicate that older adults with marijuana-only and -primary admissions have DUI and other legal problems caused by their substance use, and these adverse effects should not be ignored.

Consistent with previous study findings, marijuana use for a majority of older-adult admissions began early in life, suggesting that many older adults have used marijuana for four or more decades although some may have cycled in and out of use (Choi, DiNitto, & Marti, 2018). For those with a first treatment admission, increased physical and mental vulnerabilities due to long-term use combined with the effects of aging may have been an impetus for admission. The high criminal justice referral rates show that stressors from substance use have also become a legal liability.

While TEDS-A is a national data set, generalizability of the findings is limited due to the following data constraints. First, TEDS-A includes only admissions to publicly-supported treatment programs leaving out those admitted to private treatment sources who are likely to have more financial resources. Second, each state may have different methods and procedures for collecting data from treatment programs, resulting in large amounts of missing data for many variables. For example, substance use disorder diagnoses were not available for 65% of all admissions aged 55 + and of marijuana-involved admissions. Missing data for mental disorders ("psychiatric problems") also precluded meaningful analysis of the role of co-occurring mental disorders in treatment admissions, referrals sources, and treatment settings. More uniform and detailed data are needed, and future research should examine the effects of comorbidity of substance use and mental disorders on treatment outcomes. Third, TEDS-A does not include information on transfer from one program to another (e.g., from detoxification to residential rehabilitation or outpatient treatment). This may partly explain why a large proportion (e.g., 39% of marijuana-only cases) did not use marijuana in the past month. Fourth, since TEDS-A cases are admissions, not individuals, potential duplication/overestimation of polysubstance use problems (especially among marijuana-secondary or -tertiary admissions) is likely, as these admissions had higher rates of prior treatment episodes. Fifth, the public use TEDS-A data set does not include chronological age or more detailed age categories for the 55 + age group, precluding more in-depth analysis by age. As Sahker, Schultz, and Arndt (2015) found, there are significant age-related differences among older adults who enter substance abuse treatment (e.g., more healthcare provider/primary care referrals as age increases).

Despite its limitations, the study provides insights into older adults' admissions to public substance use treatment programs and has several implications. First, regardless of co-use of other substances, marijuana misuse in late life carries physical, mental, and legal (e.g., DUI and other) risks. With increasing numbers of older adults using marijuana, healthcare providers should screen patients for marijuana and other substance misuse, and they may need more education and more effective tools for doing so. Healthcare providers also need training in providing psychoeducation and treatment, preferably in integrated physical/behavioral healthcare settings, to better meet older substance users' complex health and behavioral health needs. Growing numbers of older-adult polysubstance users need aging-friendly specialty substance abuse treatment where they feel comfortable and their needs are appropriately met. Second, the high rates of racial/ethnic minorities and homeless people represented in polysubstance abuse admissions to public treatment also indicates that these programs need resources to offer their patients/clients comprehensive, culturally relevant, health, mental health, housing, and social services often necessary for achieving positive treatment outcomes. Third, older adults who have marijuana and other substance use problems should be educated on the harms from use or misuse of specific drugs and the need for treatment and encouraged to seek help. With this awareness, they will hopefully be more likely to seek treatment voluntarily and avoid escalating problems.

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## Author contributions

Both authors conceptualized the study; NGC did statistical analysis and drafted the manuscript; and both NGC and DMD edited and finalized it.

## Declaration of Competing Interest

None for either author.

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## References

Allison, P. (2015). When can you safely ignore multicollinearity? Retrieved from https://statisticalhorizons.com/multicollinearity.

Arndt, S., Clayton, R., & Schultz, S. K. (2011). Trends in substance abuse treatment 1998–2008: Increasing older adult first-time admissions for illicit drugs. *American Journal of Geriatric Psychiatry, 19*, 704–711. https://doi.org/10.1097/JGP.0b013e31820d942b.

Black, P., & Joseph, L. J. (2014). Still dazed and confused: Midlife marijuana use by the baby boom generation. *Deviant Behavior, 32*, 822–841.

Blow, F. C., & Barry, K. L. (2012). Alcohol and substance misuse in older adults. *Current Psychiatry Report, 14*, 310–319. https://doi.org/10.1007/s11920-012-0292-9.

Chandra, S., Radwan, M. M., Majumdar, C. G., Church, J. C., Freeman, T. P., & ElSohly, M. A. (2019). New trends in cannabis potency in USA and Europe during the last decade (2008–2017). *European Archives of Psychiatry and Clinical Neuroscience, 269*, 5–15. https://doi.org/10.1007/s00406-019-00983-5.

Chhatre, S., Cook, R., Mallik, E., & Jayadevappa, R. (2017). Trends in substance use admissions among older adults. *BMC Health Services Research, 17*(1), 584. https://doi.org/10.1186/s12913-017-2538-z.

Choi, N. G., DiNitto, D. M., & Marti, C. N. (2014). Treatment use, perceived need, and barriers to seeking treatment for substance abuse and mental disorders among older adults compared to younger adults. *Drug and Alcohol Dependence, 145*, 113–120. https://doi.org/10.1016/j.drugalcdep.2014.10.004.

Choi, N. G., DiNitto, D. M., & Marti, C. N. (2016). Older-adult marijuana users and ex-users: Comparisons of sociodemographic characteristics and mental and substance use disorders. *Drug and Alcohol Dependence, 165*, 94–102. https://doi.org/10.1016/j.drugalcdep.2016.05.023.

Choi, N. G., DiNitto, D. M., & Marti, C. N. (2017a). Nonmedical versus medical marijuana use among three age groups of adults. *The American Journal on Addictions, 26*, 697–706. https://doi.org/10.1111/ajad.12598.

Choi, N. G., DiNitto, D. M., & Marti, C. N. (2017b). Older adults who use or have used marijuana: Help-seeking for marijuana and other substance use problems. *Journal of Substance Abuse Treatment, 77*, 185–192. https://doi.org/10.1016/j.jsat.2017.02.005.

Choi, N. G., DiNitto, D. M., & Marti, C. N. (2018). A longitudinal assessment of change in marijuana use with other substance use problems. *American Journal of Drug and Alcohol Abuse, 44*, 642–652. https://doi.org/10.1080/00952990.2018.1461879.

DISA (2019). Map of marijuana legality by state. Retrieved from https://disa.com/map-of-marijuana-legality-by-state.

Han, B. H., Sherman, S., Mauro, P. M., Martins, S. S., Rotenberg, J., & Palamar, J. J. (2017). Demographic trends among older cannabis users in the United States, 2006–13. *Addiction, 112*, 516–525. https://doi.org/10.1111/add.13670.

Hasin, D. S. (2018). US epidemiology of cannabis use and associated problems. *Neuropsychopharmacology, 43*, 195–212. https://doi.org/10.1038/npp.2017.198.

Lamy, F. R., Daniulaityte, R., Sheth, A., Nahhas, R. W., Martins, S. S., Boyer, E. W., & Carlson, R. G. (2016). "Those edibles hit hard": Exploration of Twitter data on cannabis edibles in the U.S. *Drug and Alcohol Dependence, 164*, 64–70. https://doi.org/10.1016/j.drugalcdep.2016.04.029.

McCabe, S. E., West, B. T., Jutkiewicz, E. M., & Boyd, C. J. (2017). Multiple DSM-5 substance use disorders: A national study of US adults. *Human Psychopharmacology: Clinical and Experimental, 32*(5), e2625. https://doi.org/10.1002/hup.2625.

Monte, A. A., Shelton, S. K., Mills, E., Saben, J., Hopkinson, A., Sonn, B., ... Abbott, D. (2019). Acute illness associated with cannabis use, by route of exposure: An observational study. *Annals of Internal Medicine, 170*, 531–537. https://doi.org/10.7326/M18-2809.

Morse, S. A., Watson, C., MacMaster, S. A., & Bride, B. E. (2015). Differences between older and younger adults in residential treatment for co-occurring disorders. *Journal of Dual Diagnosis, 11*, 75–82. https://doi.org/10.1080/15504263.2014.993263.

National Academies of Sciences, Engineering, and Medicine (2017). *The health effects of cannabis and cannabinoids: The current state of evidence and recommendations for research.* Washington, DC: The National Academies Presshttps://doi.org/10.17226/24625 Retrieved from.

Nielsen, A. L. (2010). Americans' attitudes toward drug-related issued from 1975 to 2006: The roles of period and cohort effects. *Journal of Drug Issues, 40*, 461–494.

Sahker, E., Schultz, S. K., & Arndt, S. (2015). Treatment of substance use disorders in older adults: Implications for care delivery. *Journal of the American Geriatrics Society, 63*, 2317–2323. https://doi.org/10.1111/jgs.13706.

Salas-Wright, C. P., Vaughn, M. G., Cummings-Vaughn, L. A., Holzer, K. J., Nelson, E. J., AbiNader, M., & Oh, S. (2017). Trends and correlates of marijuana use among late middle-aged and older adults in the United States, 2002–2014. *Drug and Alcohol Dependence, 171*, 97–106. https://doi.org/10.1016/j.drugalcdep.2016.11.031.

Substance Abuse and Mental Health Services Administration (2018). *Key substance use and mental health indicators in the United States: Results from the 2017 National Survey on Drug Use and Health (HHS Publication No. SMA 18-5068, NSDUH Series H-53).* Rockville, MD: Center for Behavioral Health Statistics and Quality, Substance Abuse and Mental Health Services Administration.

Substance Abuse and Mental Health Services Administration (2019a). *Treatment Episode Data Set (TEDS): 2017. Admissions to and discharges from publicly funded substance use treatment.* Rockville, MD: Center for Behavioral Health Statistics and Quality, Substance Abuse and Mental Health Services Administration.

Substance Abuse and Mental Health Services Administration (2019b). *Treatment Episode Data Set (TEDS): 2017 codebook.* Rockville, MD: Substance Abuse and Mental Health Services Administration.