Research Paper

Associations of cannabis use, use frequency, and cannabis use disorder with violent behavior among young adults in the United States

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ABSTRACT

Background: Most violent crimes (52 %) are committed by adults aged 18–34, who account for 23 % of the US population and have the highest prevalence of cannabis use and cannabis use disorder (CUD). We examined whether and how associations of cannabis use, use frequency, and CUD with violent behavior (i.e., attacking someone with the intent to harm seriously) vary by sex in U.S. young adults.
Methods: Data were from 113,454 participants aged 18–34 in the 2015–2019 US National Surveys on Drug Use and Health, providing nationally representative data on cannabis use, CUD (using DSM-IV criteria), and violent behavior. Descriptive analyses and bivariate and multivariable logistic regression analyses were conducted.
Results: Among U.S. adults aged 18–34, 28.9 % (95 % CI = 28.5–29.2 %) reported past-year cannabis use (with/without CUD), including 20.5 % (95 % CI = 20.2–20.8 %) with non-daily cannabis without CUD, 4.7 % (95 % CI = 4.5–4.8 %) with daily cannabis use without CUD, 2.1 % (95 % CI = 1.9–2.2 %) with non-daily cannabis use and CUD, and 1.7 % (95 % CI = 1.5–1.8 %) with daily cannabis use and CUD. Past-year adjusted prevalence of violent behavior was higher among males with daily cannabis use but without CUD (2.9 %, 95 % CI = 2.4–2.7 %; adjusted prevalence ratio (PR) = 1.7, 95 % CI = 1.3–2.2) and males with daily cannabis use and CUD (3.1 %, 95 % CI = 2.3–4.0 %; adjusted PR = 1.8, 95 % CI = 1.3–2.4) than males without past-year cannabis use (1.7 %, 95 % CI = 1.6–1.9 %). Adjusted prevalence of violent behavior was higher among females with cannabis use regardless of daily cannabis use/CUD status (adjusted prevalence = 1.6–2.4 %, 95 % CIs = 0.9–3.2 %; adjusted PRs = 1.6–2.4, 95 % CI = 1.3–3.2) than females without past-year cannabis use (1.0 %, 95 % CI = 0.9–1.1 %).
Conclusions: Research is needed to ascertain the directionality of the associations between cannabis use and violent behavior and underlying sex-specific mechanism(s). Our results point to complex sex-specific relationships between cannabis use frequency, CUD, and violent behavior and highlight the importance of early screening for and treatment of CUD and of preventive interventions addressing cannabis misuse.

Introduction

An association between cannabis use and violence has been reported for decades (Goldstein, 1985; Stepjanović et al., 2023; Zhong et al., 2020). Yet, the increases in US state legalization of medical and non-medical cannabis, in the potency of cannabis (ElSohly et al., 2021), and in the prevalence of cannabis use, cannabis use disorder (CUD) (Han, 2020) and daily/near daily cannabis use (hereafter "daily cannabis use", Compton et al., 2019) emphasize the need to re-examine their associations with violent behavior.

A key complexity in unraveling the relationship of cannabis with violent behaviors is the overlap of cannabis use with other substances. People who use cannabis are likely to have polysubstance use (Compton et al., 2016; Compton et al., 2021), consistent with findings of shared genetic vulnerability for substance use disorder (SUD) risk across various types of substances (Hatoum et al., 2023). After controlling for other drug use disorders based on earlier US nationally representative data, researchers (Ghossoub et al., 2022; Harford et al., 2018; Salas-Wright et al., 2016; Smith et al., 2012) reported associations between past-year CUD and violent behavior. However, these researchers did not adjust for methamphetamine use, use frequency, or use disorder. Because there have been marked increases in methamphetamine use, use frequency, and use disorder (Han et al., 2021a), and because methamphetamine use and use disorder are consistently associated with violent behavior (Stepjanović et al., 2023; Zhong et al., 2020), research is needed to better understand whether and how CUD is associated with

violent behavior after controlling for methamphetamine use, use frequency, and use disorder, in addition to adjusting for other substances.

Furthermore, CUD criteria do not include a cannabis use frequency measure and could have reporting bias due to increases in legal and social acceptance of cannabis use and decreases in perceived harmfulness of cannabis use (Compton et al., 2019). By contrast, daily cannabis use, a frequency measure, is substantially concordant with CUD diagnostic criteria (Compton et al., 2013) and associated with more mental health problems and behavioral issues (e.g., aggression (Dellazizzo et al., 2020), antisocial personality disorder (Lowe et al., 2019)). An association between frequent cannabis use and violent behavior has been reported based on the review of 14 cases of violence (Miller et al., 2020) and examinations of local community samples (Friedman et al., 1996; Schoeler et al., 2016; Stepjanović et al., 2023; White et al., 2015), people in the early phase of psychosis (Moulin et al., 2022), and patients with severe mental illness such as schizophrenia (Beaudoin et al., 2020). To examine the generalizability of these findings, it is necessary to examine whether and how cannabis use, use frequency, and CUD are associated with violent behavior in the general population.

In addition, some researchers reported a stronger association between cannabis use and violence in males than females based on community samples (Feingold & Capaldi, 2014; Feingold, Kerr & Capaldi, 2008) and from a systematic review (Stepjanović et al., 2023). However, other researchers reported a stronger association between cannabis use and violence in females than males from a systematic review and meta-analysis (Johnson et al., 2017) and based on US nationally representative data collected in 2004–2005 (focusing on CUD; Smith et al., 2012). To clarify sex differences and help inform sex-specific prevention and intervention strategies, we have examined whether and how associations of cannabis use, use frequency, and CUD with violent behavior vary by sex in the general population.

According to the US Federal Bureau of Investigation data, distributions of US violent crime offenses in 2019 included 53 % committed by adults aged 18–34 (US Federal Bureau of Investigation (FBI), 2019). However, only 23 % of the US population was aged 18–34 (US Census Bureau, 2023). U.S. adults aged 18–34, who account for most of the violent crimes (US FBI, 2019), have the highest prevalence of cannabis use and CUD (Han, 2020). Thus, this study examined specific prevalence and associations of cannabis use, use frequency, and CUD with violent behavior among U.S. adults aged 18–34.

Methods

Study design and data sources

Data were from participants aged 18–34 in the 2015–2019 National Surveys on Drug Use and Health (NSDUH), providing nationally representative data on substance use, SUD, and violent behavior among U.S. civilian, noninstitutionalized adult populations (Han, 2020). The NSDUH data collection protocol was approved by the Institutional Review Board (IRB) at the Research Triangle Institute International. Data were collected by interviewers in personal visits to households and noninstitutional group quarters. Each participant provided verbal informed consent (Han, 2020). Audio computer-assisted self-administered interviewing was used, providing respondents with a private, confidential way to record answers. For the 2015–2019 NSDUH, the annual mean weighted screening response rate was 75.3 %, and the annual mean weighted interview response rate was 67.3 % (Substance Abuse and Mental Health Services Administration (SAMHSA), 2023; Han et al., 2021a). This study used publicly available deidentified data and is exempt from review per the US National Institutes of Health IRB. This study followed the STROBE reporting guideline for observational (cross-sectional) studies.

Measures

NSDUH asked adult respondents: *"During the past 12 months, how many times have you attacked someone with the intent to seriously hurt them?"* (hereafter "violent behavior" in the past year) (Han, 2020). This measure has been examined in many studies (Ghossoub et al., 2022; Grucza et al., 2018; Hai et al., 2022; Harford et al., 2018; Salas-Wright et al., 2016; Salas-Wright et al., 2017).

NSDUH also collected past-year substance use, use frequency, and specific SUD based on DSM-IV diagnostic criteria (American Psychiatry Association, 1994; Han, 2020), including alcohol use disorder (AUD), CUD, cocaine, heroin, hallucinogen, or methamphetamine use disorder, and prescription opioid, stimulant, sedative, or tranquilizer disorder. Misuse of prescription psychotropic medications is defined as "use in any way not directed by a doctor, including use without a prescription of one's own; use in greater amounts, more often, or longer than told to take a drug; or use in any other way not directed by a doctor" (Han, 2020). NSDUH asked the frequency of past-month (rather than past-year) misuse of prescription psychotropic medications among people who reported misusing them in the past year. We defined daily or near-daily cannabis use (hereafter daily cannabis use) as having ≥300 days of cannabis use in the past year.

Among NSDUH respondents who reported past-month cigarette smoking, past-month nicotine dependence was defined as meeting either the Nicotine Dependence Syndrome Scale (NDSS) or the Fagerstrom Test of Nicotine Dependence (FTND) criteria for dependence (Han, 2020). NSDUH assessed any mental illness among adult participants, which is based on a predictive model and aligns with DSM-IV criteria and is defined as having a diagnosable mental, behavioral, or emotional disorder, other than a developmental or substance use disorder (Han, 2020; SAMHSA, 2023). NSDUH asked respondents about sociodemographic characteristics. Additional details about NSDUH methods and survey questionnaires are available (SAMHSA, 2023).

Statistical analyses

Descriptive analyses and bivariate and multivariable logistic regression analyses were conducted. Model-adjusted prevalence (predicted marginal proportion) (Bieler et al., 2010) and adjusted prevalence ratios (APR) of violent behavior were estimated. Multicollinearity was not found in our final multivariable logistic regression model. However, we identified significant interaction effects between sex and cannabis use, use frequency, and CUD ($P = .004$), between sex and age ($P = .02$), between sex and MSA status ($P = .01$), between sex and any mental illness ($P = .02$), between sex and methamphetamine use, use frequency, use disorder ($P = .02$), between sex and prescription opioid misuse, misuse frequency, and use disorder ($P = .04$), and between sex and prescription stimulant misuse, misuse frequency, and use disorder ($P = .01$). Thus, stratified multivariable logistic regression models by sex were applied.

SUDAAN software, version 11.0.3 (RTI International) was used for all data analyses to account for the complex sample design and sample weights of NSDUH. For each analysis, $P < 0.05$ (2-tailed) was considered statistically significant. Data were analyzed during January 27–29, 2024.

Results

Violent behavior

Among 113,932 adults aged 18–34 who participated in the 2015–2019 NSDUH, 478 (0.42 %, unweighted; "bad data": $n = 30$; "don't know": $n = 161$; "refused": $n = 265$; "blank": $n = 22$) did not answer the question of how many times they attacked people with intent to harm seriously. Thus, we examined the remaining 113,454 adults. Their response distribution was: "0 times": $n = 111,278$; "1–2 times": n
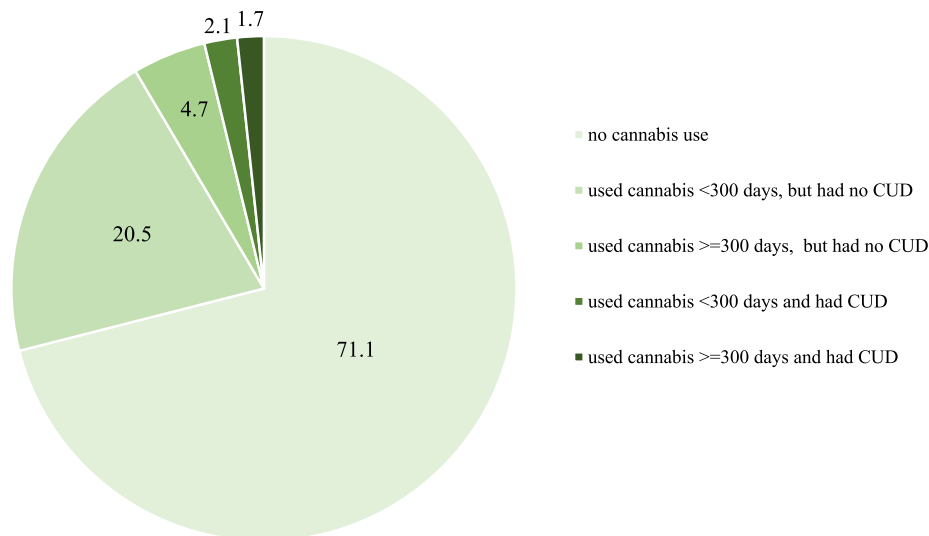
Fig. 1. Past-year prevalence of cannabis use, use frequency, and cannabis use disorder (CUD) among US adults aged 18–34, weighted percentage. Data source: 2015–2019 National Surveys on Drug Use and Health.
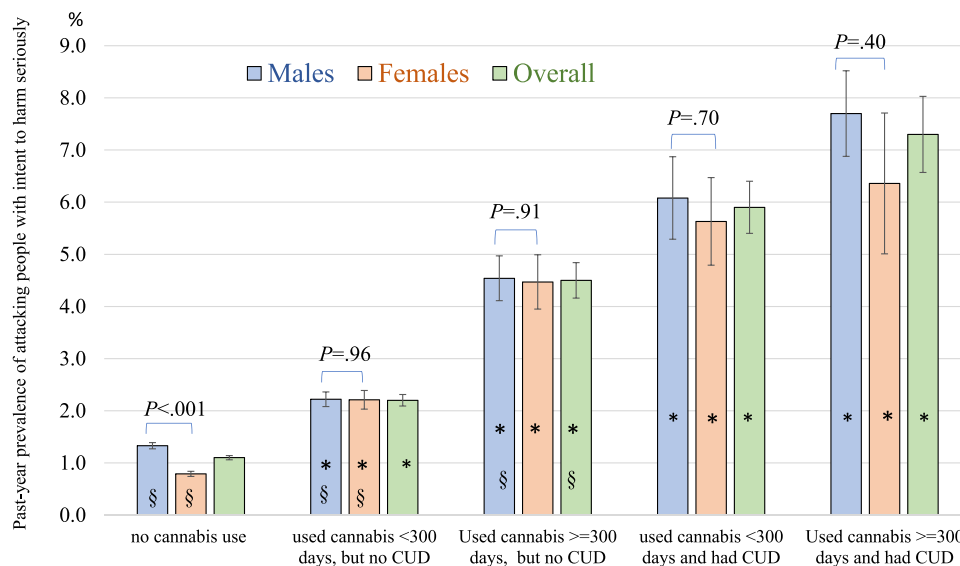

Fig. 2. Past-year prevalence of attacking people with intent to harm seriously by past-year cannabis use frequency and cannabis use disorder (CUD) among US adults aged 18–34, overall and by sex.

Data source: 2015–2019 National Surveys on Drug Use and Health. *: Within each group, the estimate was statistically significantly different (*P* < .05) from the corresponding estimate for no past-year cannabis use. §: Within each group, the estimate was statistically significantly different (*P* < .05) from the corresponding estimate for past-year cannabis use >=300 days and CUD. Error bar=standard error.

= 1776; "3–5 times": *n* = 246; "6–9 times": *n* = 59; and "≥10 times": *n* = 95). To have a sufficient sample size for young adults who attacked people with intent to harm seriously, we recoded this violent behavior outcome as a binary variable (yes: ≥1 times; no: 0 times).

Final study sample and unadjusted prevalence of cannabis use, use frequency, and CUD

Among the 113,454 sampled young adults, 49.8 % were male; 34.7 % were 18–23-year-olds and 65.3 % were 24–34-year-olds; 21.2 % were Hispanic, 13.5 % were non-Hispanic Black, and 55.3 % were non-Hispanic White. Among U.S. adults aged 18–34, 28.9 % (weighted percentage hereafter, 95 % CI = 28.5–29.2 %) reported cannabis use (with or without CUD) in the past year, including 20.5 % (95 % CI = 20.2–20.8 %) with non-daily cannabis without CUD, 4.7 % (95 % CI =

4.5–4.8 %) with daily cannabis use without CUD, 2.1 % (95 % CI = 1.9–2.2 %) with non-daily cannabis use and CUD, and 1.7 % (95 % CI = 1.5–1.8 %) with daily cannabis use and CUD (Fig. 1).

Unadjusted prevalence of violent behavior by cannabis use, use frequency, and CUD

Among young adults in the US, past-year unadjusted prevalence of violent behavior was 1.1 % (95 % CI = 1.0–1.1 %) among those without past-year cannabis use, 2.2 % (95 % CI = 2.0–2.5 %) among those with non-daily cannabis use without CUD, 4.5 % (95 % CI = 3.9–5.2 %) among those with daily cannabis use but without CUD, 5.9 % (95 % CI = 5.0–7.0 %) among those with non-daily cannabis use and CUD, and 7.3 % (95 % CI = 6.0–8.9 %) among those with daily cannabis use and CUD (Fig. 2). Compared to adults without past-year cannabis use, past-year

Table 1

Past-year unadjusted prevalence of attacking people with intent to harm seriously by sociodemographic characteristics among US adults aged 18–34.

Sociodemographic characteristics	Unadjusted prevalence (95 % CI)	Unadjusted prevalence ratio (95 % CI)
Year		
2015+	2.0 (1.8–2.2)	1.0
2016	1.7 (1.5–1.9)	**0.8 (0.7–0.9)**
2017	1.8 (1.6–2.0)	0.9 (0.8–1.1)
2018	1.4 (1.2–1.6)	**0.7 (0.6–0.8)**
2019	1.4 (1.2–1.7)	**0.7 (0.6–0.9)**
Age		
18–20	2.9 (2.7–3.2)	**3.0 (2.5–3.6)**
21–23	2.1 (1.9–2.3)	**2.1 (1.8–2.6)**
24–29	1.4 (1.2–1.5)	**1.4 (1.2–1.7)**
30–34+	1.0 (0.9–1.1)	1.0
Sex		
Male	2.0 (1.9–2.1)	**1.5 (1.3–1.7)**
Female +	1.3 (1.2–1.5)	1.0
Race/Ethnicity		
Hispanic +	1.6 (1.5–1.8)	1.0
NH AIAN	3.3 (2.4–4.7)	**2.0 (1.4–2.9)**
NH Asian	0.7 (0.5–1.0)	**0.4 (0.3–0.6)**
NH Black	3.0 (2.7–3.3)	**1.8 (1.5–2.1)**
NH Native Hawaiian or Other Pacific Islander	3.4 (1.5–7.8)	2.1 (0.9–4.9)
NH, > 1 race	2.8 (2.2–3.5)	**1.7 (1.3–2.2)**
NH White	1.4 (1.3–1.5)	**0.8 (0.7–1.0)**
Educational Attainment		
< High school	3.1 (2.8–3.5)	**8.1 (6.1–10.7)**
High school	2.4 (2.2–2.6)	**6.3 (4.8–8.4)**
Some college	1.6 (1.4–1.7)	**4.1 (3.1–5.3)**
College graduate +	0.4 (0.3–0.5)	1.0
Family Income		
<$20,000	2.5 (2.3–2.8)	**2.1 (1.8–2.5)**
$20,000-$49,999	1.8 (1.6–2.0)	**1.5 (1.3–1.8)**
$50,000-$74,999	1.1 (0.9–1.3)	0.9 (0.7–1.2)
≥$75,000	1.2 (1.0–1.3)	1.0
Marital Status		
Married +	0.7 (0.6–0.8)	1.0
Divorced/Separated	1.8 (1.4–2.5)	**2.7 (1.9–3.6)**
Never married	2.0 (1.9–2.1)	**2.9 (2.4–3.4)**
Other	6.7 (4.2–9.6)	**9.2 (5.8–14.5)**
Metropolitan Statistical Area (MSA)		
Large MSA	1.6 (1.4–1.7)	**0.8 (0.4–0.9)**
Small MSA	1.7 (1.5–1.9)	**0.8 (0.7–1.0)**
Non-MSA +	2.1 (1.8–2.4)	1.0

Data source: 2015–2019 National Surveys on Drug Use and Health. NH=non-Hispanic. NH=non-Hispanic. AIAN=American Indian or Alaska Native. +: reference group. **Bold** estimates are statistically significantly different (*P* < .05) from the estimate of the reference group. Non-MSA=non-metropolitan statistical area: an area no part of which is within an area designated as a standard metropolitan statistical area by the U.S. Office of Management and Budget and which does not contain a city whose population exceeds fifty thousand individuals.

unadjusted prevalence of violent behavior was 2.1 times higher (unadjusted PR = 2.1, 95 % CI = 1.9–2.4) among adults with non-daily cannabis use but without CUD and was 7.0 times higher (unadjusted PR = 7.0, 95 % CI = 5.7–8.5) among adults with daily cannabis use and CUD (Table 2).

Unadjusted prevalence of violent behavior by sex and other sociodemographic characteristics

For males (Fig. 2), past-year unadjusted prevalence of violent behavior was 1.3 % (95 % CI = 1.2–1.5 %) among those without past-year cannabis use, 2.2 % (95 % CI = 2.0–2.5 %) among those with non-daily cannabis use without CUD, 4.5 % (95 % CI = 3.8–5.5 %) among those with daily cannabis use without CUD, 6.1 % (95 % CI = 4.7–7.9 %) among those with non-daily cannabis use and CUD, and 7.7 % (95 % CI = 6.2–9.5 %) among those with daily cannabis use and CUD.

Table 2

Past-year unadjusted prevalence of attacking people with intent to harm seriously by any mental illness, substance use, use frequency, and substance use disorders among US adults aged 18–34.

Any mental illness, substance use, use frequency, and use disorders in the past year	Unadjusted prevalence (95 % CI)	Unadjusted prevalence ratio (95 % CI)
Any Mental Illness (Excluding Substance Use Disorder)		
Yes	3.4 (3.1–3.6)	**3.1 (2.8–3.5)**
No +	1.1 (1.0–1.2)	1.0
Nicotine Dependence		
No past-year cigarette use +	1.0 (1.0–1.1)	1.0
PY cigarette use, but no PM cigarette use	1.9 (1.6–2.3)	**1.9 (1.5–2.3)**
PM cigarette use, no PM nicotine dependence	2.4 (2.1–2.7)	**2.2 (1.9–2.5)**
PM cigarette use, PM nicotine dependence	4.4 (4.0–4.8)	**4.0 (3.5–4.5)**
Cannabis Use, Use Frequency, and Use Disorder		
No past-year use +	1.1 (1.0–1.1)	1.0
Used <300 days, had no cannabis use disorder	2.2 (2.0–2.5)	**2.1 (1.9–2.4)**
Used ≥300 days, had no cannabis use disorder	4.5 (3.9–5.2)	**4.3 (3.6–5.1)**
Used <300 days, had cannabis use disorder	5.9 (5.0–7.0)	**5.7 (4.6–6.9)**
Used ≥300 days, had cannabis use disorder	7.3 (6.0–8.9)	**7.0 (5.7–8.5)**
Alcohol Use, Use Frequency, and Use Disorder		
No past-year use +	1.4 (1.2–1.6)	1.0
Used <300 days, had no alcohol use disorder	1.2 (1.1–1.4)	0.9 (0.8–1.1)
Used ≥300 days, had no alcohol use disorder	1.9 (1.2–3.0)	1.4 (0.9–2.3)
Used <300 days, had alcohol use disorder	5.0 (4.5–5.7)	**3.7 (3.1–4.4)**
Used ≥300 days, had alcohol use disorder	6.1 (4.6–8.1)	**4.5 (3.2–6.3)**
Cocaine Use, Use Frequency, and Use Disorder		
No past-year use +	1.5 (1.4–1.6)	1.0
Used <50 days, had no cocaine use disorder	3.8 (3.2–4.6)	**2.6 (2.1–3.1)**
Used ≥50 days, had no cocaine use disorder	5.2 (3.3–8.1)	**3.5 (2.2–5.6)**
Used <50 days, had cocaine use disorder	8.7 (5.7–12.9)	**5.9 (3.9–8.9)**
Used ≥50 days, had cocaine use disorder	15.8 (11.1–22.0)	**10.7 (7.5–15.2)**
Methamphetamine Use, Use Frequency, and Use Disorder		
No past-year use +	1.6 (1.5–1.6)	1.0
Used <50 days, had no methamphetamine use disorder	8.6 (5.7–12.6)	**5.5 (3.7–8.1)**
Used ≥50 days, had no methamphetamine use disorder	7.8 (4.0–14.6)	**5.0 (2.6–9.7)**
Used <50 days, had methamphetamine use disorder	10.4 (5.1–20.0)	**6.7 (3.4–13.3)**
Used ≥50 days, had methamphetamine use disorder	14.8 (11.9–18.4)	**9.6 (7.6–12.0)**
Hallucinogen Use, Use Frequency, and Use Disorder		
No past-year use+	1.5 (1.4–1.6)	1.0
Used <12 days, had no hallucinogen use disorder	3.8 (3.2–4.5)	**2.6 (2.1–3.1)**
Used ≥12 days, had no hallucinogen use disorder	6.2 (4.8–8.0)	**4.2 (3.3–5.5)**
Used <12 days, had no hallucinogen use disorder	12.6 (7.7–20.0)	**8.6 (5.3–14.0)**
Used ≥12 days, had no hallucinogen use disorder	17.1 (11.8–24.3)	**11.6 (8.0–16.8)**
Heroin Use and Use Disorder		
No past-year use +	1.6 (1.5–1.7)	1.0
Used, but had no heroin use disorder	5.6 (3.0–10.4)	**3.5 (1.9–6.5)**

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Table 2 (*continued*)

Any mental illness, substance use, use frequency, and use disorders in the past year	Unadjusted prevalence (95 % CI)	Unadjusted prevalence ratio (95 % CI)
Heroin use disorder	8.0 (5.4–11.6)	**4.9 (3.3–7.3)**
Rx Opioid Misuse, Misuse Frequency, and Use Disorder		
No past-year (PY) misuse +	1.4 (1.3–1.5)	1.0
PY misuse, but no PM misuse, no PY Rx opioid use disorder	4.7 (4.0–5.6)	**3.4 (2.9–4.1)**
Past-month (PM) misused <6 days, no PY Rx opioid use disorder	6.1 (4.7–7.8)	**4.4 (3.3–5.8)**
PM misused ≥6 days, no PY Rx opioid use disorder	6.2 (3.8–9.8)	**4.5 (2.8–7.1)**
PY misuse, but no PM misuse, had PY Rx opioid use disorder	6.5 (4.8–8.8)	**4.7 (3.5–6.4)**
PM misused <6 days, had PY Rx opioid use disorder	9.5 (6.1–14.5)	**6.8 (4.4–10.7)**
PM misused ≥6 days, had PY Rx opioid use disorder	11.0 (7.4–16.1)	**8.0 (5.4–11.9)**
Rx Stimulant Misuse, Misuse Frequency, and Use Disorder		
No past-year (PY) misuse +	1.5 (1.5–1.6)	1.0
PY misuse, but no PM misuse, no PY Rx stimulant use disorder	3.1 (2.5–3.9)	**2.0 (1.6–2.5)**
Past-month (PM) misused <6 days, no PY Rx stimulant use disorder	4.2 (2.9–6.0)	**2.7 (1.8–4.0)**
PM misused ≥6 days, no PY Rx stimulant use disorder	7.0 (3.6–13.3)	**4.6 (2.4–8.8)**
PY Rx stimulant use disorder	6.6 (4.7–9.4)	**4.3 (3.0–6.2)**
Rx Tranquilizer Misuse, Misuse Frequency, and Use Disorder		
No past-year (PY) misuse +	1.5 (1.4–1.5)	1.0
PY misuse, but no PM misuse, no PY Rx tranquilizer use disorder	5.0 (4.2–5.9)	**3.4 (2.8–4.1)**
Past-month (PM) misused <6 days, no PY Rx tranquilizer use disorder	6.3 (4.3–9.0)	**4.3 (3.0–6.4)**
PM misused ≥6 days, no PY Rx tranquilizer use disorder	9.5 (6.4–13.9)	**6.6 (4.4–9.7)**
PY Rx tranquilizer use disorder	12.1 (9.2–15.8)	**8.4 (6.3–11.1)**
Rx Sedative Misuse, Misuse Frequency, and Use Disorder		
No past-year (PY) misuse+	1.6 (1.5–1.7)	1.0
Past-month (PM) misused <3 days, no PY Rx. sedative use disorder	5.1 (3.3–7.6)	**3.1 (2.1–4.7)**
PM misused ≥3 days or PY Rx. sedative use disorder	9.6 (4.9–17.8)	**5.9 (3.0–11.5)**

Data source: 2015–2019 National Surveys on Drug Use and Health. Rx=Prescription; PY=Past year; PM=Past month. The sample size for young adults with Rx. sedative use disorder is too limited to provide a valid estimate. +: reference group. **Bold** estimates are statistically significantly different ($P < .05$) from the estimate of the reference group.

Similarly, for females, it was 0.8 % (95 % CI = 0.7–0.9 %) among those without past-year cannabis use, 2.2 % (95 % CI = 1.9–2.6 %) among those with non-daily cannabis use without CUD, 4.5 % (95 % CI = 3.5–5.6 %) among those with daily cannabis use without CUD, 5.6 % (95 % CI = 4.2–7.6 %) among those with non-daily cannabis use and CUD, and 6.4 % (95 % CI = 4.1–9.7 %) among those with daily cannabis use and CUD. Among young adults without past-year cannabis use, past-year unadjusted prevalence of violent behavior was higher among males than females ($P < .001$). However, among those with cannabis use, it did not differ by sex within each examined cannabis use, use frequency, and use disorder category.

Past-year unadjusted prevalence of violent behavior was higher in 2015 than in 2016, 2018, and 2019, for ages 18–29 than ages 30–34, for males than females, for non-Hispanic American Indians or Alaska Natives (AIAN), Black adults, and adults with more than one race than Hispanic adults, non-college graduates than college graduates, those with annual family income <$50,000 than those with ≥75,0000, unmarried adults than married adults, and non-MSA residents than MSA residents (Table 1). However, it was lower in non-Hispanic Asians and non-Hispanic White adults than Hispanic adults.

Unadjusted prevalence of violent behavior by other behavior health status

Past-year unadjusted prevalence of violent behavior was higher among adults with any mental illness than those without, adults with past-year cigarette use than those without, adults with alcohol use disorder than those without, adults with past-year use of cocaine, heroin, and methamphetamine than those without, and adults with past-year misuse of prescription opioids, stimulants, sedatives, and tranquilizers than those without (Table 2). For example, compared to adults without past-year methamphetamine use, past-year unadjusted prevalence of violent behavior was 5.5 times higher (unadjusted PR = 5.5, 95 % CI = 3.7–8.1) among adults who used methamphetamine for <50 days and had no methamphetamine use disorder and was 9.6 times higher (unadjusted PR = 9.6, 95 % CI = 7.6–12.0) among adults who used methamphetamine for ≥50 days and had methamphetamine use disorder.

Adjusted prevalence of violent behavior by sex, cannabis use, use frequency, and CUD

For males (Fig. 3, Table 3), past-year adjusted prevalence of violent behavior was higher among adults with daily cannabis use without CUD (2.9 %, 95 % CI = 2.4–2.7 %; adjusted PR = 1.7, 95 % CI = 1.3–2.2) and among adults with daily cannabis use and CUD (3.1 %, 95 % CI = 2.3–4.0 %; adjusted PR = 1.8, 95 % CI = 1.3–2.4) than among adults without past-year cannabis use (1.7 %, 95 % CI = 1.6–1.9 %). However, past-year adjusted prevalence of violent behavior among those without past-year cannabis use did not significantly differ from those with non-daily cannabis use but without CUD (1.9 %, 95 % CI = 1.6–2.1 %; adjusted PR = 1.1, 95 % CI = 0.9- = 1.3) and those with non-daily cannabis use and with CUD (2.4 %, 95 % CI = 1.8–3.3 %; adjusted PR = 1.4, 95 % CI = 1.0–2.0). The adjusted prevalence of violent behavior among males was lower in 2018–2019 than in 2015 (1.6 % vs. 2.3 %; PRs = 0.7, 95 % CIs = 0.5–0.9).

For females (Fig. 3, Table 3), past-year adjusted prevalence of violent behavior was higher among adults with nondaily cannabis use but without CUD (1.6 %, 95 % CI = 1.4–2.0 %; adjusted PR = 1.6, 95 % CI = 1.3–2.0), among adults with daily cannabis use but without CUD (2.4 %, 95 % CI = 1.8–3.0 %; adjusted PR = 2.4, 95 % CI = 1.8–3.2), among adults without daily cannabis use but with CUD (1.9 %, 95 % CI = 1.4–2.7 %; adjusted PR = 1.9, 95 % CI = 1.4–2.7), and among adults with daily cannabis use and CUD (2.0 %, 95 % CI = 1.3–3.2 %; adjusted PR = 2.0, 95 % CI = 1.2–3.2) than among adults without past-year cannabis use (1.0 %, 95 % CI = 0.9–1.1 %). The adjusted prevalence of violent behavior among females was lower in 2018 than in 2015 (1.1 % vs. 1,6 %; PR = 0.7, 95 % CI = 0.5–0.9).

Compared to adults without past-year cannabis use, adjusted PR was higher among females with non-daily cannabis use but without CUD than their male counterparts ($P = .005$, Table 3). Adjusted prevalence of violent behavior was higher among males without past-year cannabis use than their female counterparts (Fig. 3). However, within each category of cannabis use, use frequency, and CUD among those with past-year cannabis use, adjusted prevalence of violent behavior did not significantly differ by sex. Moreover, adjusted prevalence of violent behavior was higher among males with daily cannabis use and CUD than among males with non-daily cannabis use without CUD.

Adjusted prevalence of violent behavior by sex, other substance use, use frequency, and SUD

For males, compared to those without the corresponding substance use in the past year, adjusted prevalence of violent behavior was higher among those with past-month cigarette use regardless of past-month nicotine dependence status, among those with alcohol use disorder regardless of daily alcohol use status, among those who used methamphetamine for ≥50 days and had methamphetamine use disorder, among those who used cocaine for ≥50 days and had cocaine use
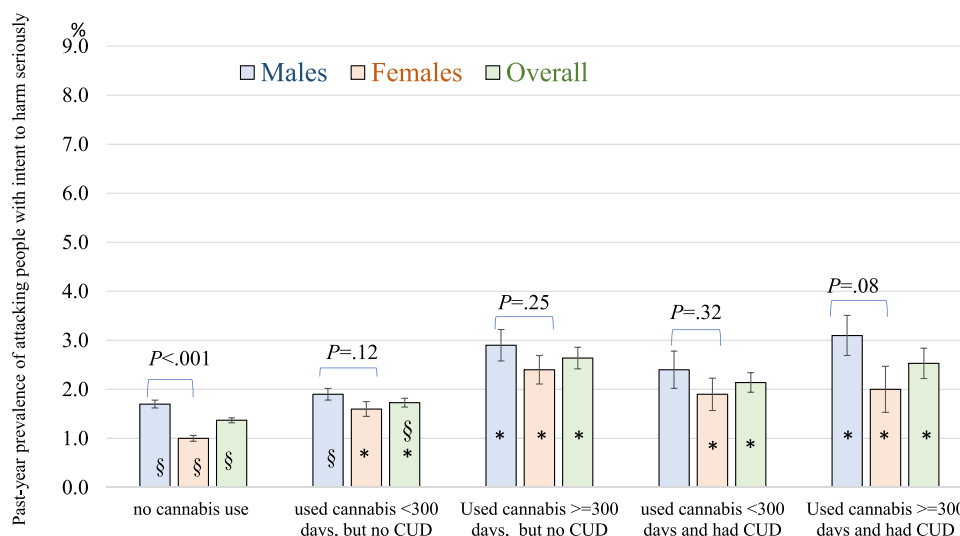
Fig. 3. Adjusted past-year prevalence of attacking people with intent to harm seriously by past-year cannabis use frequency and cannabis use disorder (CUD) among US adults aged 18–34, overall and by sex.

Data source: 2015–2019 National Surveys on Drug Use and Health. Each estimate was adjusted for survey year, age, race/ethnicity, education, marital status, metropolitan statistical area status, any mental illness, nicotine dependence, alcohol, methamphetamine, and cocaine use, use frequency, and use disorder, and prescription opioid, stimulant, and tranquilizer misuse, misuse frequency, and use disorders. *: Within each group, the estimate was statistically significantly different ($P < .05$) from the corresponding estimate for no past-year cannabis use. §: Within each group, the estimate was statistically significantly different ($P < .05$) from the corresponding estimate for past-year cannabis use >=300 days and CUD. Error bar=standard error.

disorder, and among males with past-month prescription tranquilizer misuse regardless of prescription tranquilizer use disorder. For females, compared to those without the corresponding substance use in the past year, adjusted prevalence of violent behavior was higher among those with past-month nicotine dependence, among those without daily alcohol use but with alcohol use disorder, among those who reported methamphetamine use, and among those who misused prescription opioids for ≥6 days in the past month regardless of their past-year prescription opioid use disorder status.

Other sex differences

In addition, compared to their corresponding female counterparts, adjusted PR was higher among males aged 18–20 but was lower among males residing in MSA (Table 3). However, adjusted PR was higher among females with any mental illness, females who used methamphetamine for <50 days and had no methamphetamine use disorder, and females who misused prescription opioids for ≥6 days but had no prescription opioid use disorder than their corresponding male counterparts.

Discussion

Using nationally representative data, our study identified associations of cannabis use, use frequency, and CUD with violent behavior among U.S. adults aged 18–34, which varied by sex. Although we cannot establish directionality nor causal relationships based on the cross-sectional nature of NSDUH data, we identified elevated adjusted prevalence of violent behavior among males with daily cannabis use regardless of their CUD status and among females with cannabis use regardless of their daily cannabis use and CUD status. These findings are consistent with findings that among adolescents, cannabis use and CUD were associated with higher prevalence of aggressive behavior (Brook et al., 2014; Sultan et al., 2023).

Cannabis sales, cannabis use, CUD, daily cannabis use, and daily doses of delta-9-tetrahydrocannabinol (THC) (the main addictive component of cannabis) consumed all have increased over the past decades (ElSohly et al., 2021; Han, 2020). These patterns of consumption

could plausibly increase violence by producing cognitive impairment and heightening impulsive behavior (Stepjanović et al., 2023). Consistently, we found elevated violent behavior among males with daily cannabis use, especially among young men aged 18–23. Moreover, our results suggest that for young adults with cannabis use but without daily cannabis use and CUD, the psychopharmacological effects of cannabis may reduce the threshold for violent behavior among females more than among males. Although prevalence of violent behavior is higher among males without cannabis use than among their female counterparts, adjusted prevalence of violent behavior did not significantly differ by sex for each examined category of cannabis use, use frequency, and CUD among young adults with cannabis use. Regular and high dose cannabis consumption patterns have been linked to cannabis-induced paranoia, acute psychosis (Murray & Hall, 2020; Petrilli et al., 2022) and schizophrenia (Petrilli et al., 2022; Hjorthøj et al., 2023), especially among young men (Hjorthøj et al., 2023). Researchers have also found strong evidence between frequent cannabis use and violence among people with psychosis, which may reflect cannabis exacerbation of judgment impairments, paranoid thinking, and impulsivity among this population (Dellazizzo et al., 2020; Stepjanović et al., 2023).

Researchers have also highlighted the behavioral characteristics of people with cannabis use, including greater likelihood to exhibit antisocial behaviors (Hall & Degenhardt, 2007) and interpersonal violence (Moore & Stuart, 2005), more engagement in risk-taking, and more inclination to use other substances associated with violent behavior (Dellazizzo et al., 2020). The increased risks of violent behavior with co-morbid patterns of substance use could also reflect common vulnerability factors for violence and substance use (Stepjanović et al., 2023; Schoeler et al., 2016). People who commit violent offenses are more likely to use substances (Schoeler et al., 2016). As such, it is difficult to ascertain based on cross-sectional data whether increases in violent behavior are due to cannabis use or whether people who exhibit violent behavior are more likely to use cannabis.

Consistent with increases in cannabis use and CUD prevalence (ElSohly et al., 2021; Han, 2020), recent research has found marked increases in methamphetamine use and use disorder among U.S. adults (Han et al., 2021a). Our study shows elevated adjusted prevalence of violent behavior among males with frequent methamphetamine use and

Table 3

Final multivariable logistic regression model and stratified models showing correlates and past-year adjusted prevalence of attacking people with intent to harm seriously among male and female adults aged 18–34 in the US.

Sociodemographic characteristics, any mental illness, substance use, use frequency, and substance use disorders	Males		Females	
	Adjusted prevalence (95 % CI)	Adjusted prevalence ratio (95 % CI)	Adjusted prevalence (95 % CI)	Adjusted prevalence ratio (95 % CI)
Cannabis Use, Use Frequency, and Use Disorder				
No use +	1.7 (1.6–1.9)	1.0	1.0 (0.9–1.1)	1.0
Used <300 days, had no cannabis use disorder	1.9 (1.6–2.1)	1.1 (0.9–1.3) [A]	1.6 (1.4–2.0)	**1.6 (1.3–2.0)** [A]
Used ≥300 days, had no cannabis use disorder	2.9 (2.4–3.7)	**1.7 (1.3–2.2)**	2.4 (1.8–3.0)	**2.4 (1.8–3.2)**
Used <300 days, had cannabis use disorder	2.4 (1.8–3.3)	1.4 (1.0–2.0)	1.9 (1.4–2.7)	**1.9 (1.4–2.7)**
Used ≥300 days, had cannabis use disorder	3.1 (2.3–4.0)	**1.8 (1.3–2.4)**	2.0 (1.3–3.2)	**2.0 (1.2–3.2)**
Year				
2015 +	2.3 (2.0–2.6)	1.0	1.6 (1.3–1.9)	1.0
2016	2.1 (1.8–2.5)	0.9 (0.7–1.2)	1.4 (1.2–1.7)	0.9 (0.7–1.1)
2017	2.3 (1.9–2.7)	1.0 (0.8–1.3)	1.4 (1.1–1.7)	0.9 (0.7–1.1)
2018	1.6 (1.3–2.0)	**0.7 (0.5–0.9)**	1.1 (0.9–1.4)	**0.7 (0.5–0.9)**
2019	1.6 (1.4–2.0)	**0.7 (0.6–0.9)**	1.2 (1.0–1.5)	0.8 (0.6–1.0)
Age				
18–20	3.3 (2.8–3.8)	**2.6 (1.9–3.6)** [A]	1.7 (1.4–2.0)	**1.7 (1.2–2.3)** [A]
21–23	2.4 (2.1–2.8)	**2.0 (1.5–2.7)**	1.4 (1.2–1.6)	**1.4 (1.0–1.8)**
24–29	1.5 (1.3–1.8)	1.2 (0.9–1.7)	1.3 (1.1–1.5)	**1.2 (1.0–1.5)**
30–34+	1.2 (1.0–1.6)	1.0	1.0 (08–1.3)	1.0
Race/Ethnicity				
Hispanic +	2.0 (1.7–2.4)	1.0	1.4 (1.2–1.7)	1.0
NH AIAN	3.0 (1.9–4.7)	1.5 (0.9–2.4)	1.8 (1.1–2.9)	1.4 (0.8–2.3)
NH Asian	1.8 (1.3–2.6)	0.9 (0.6–1.4)	0.8 (0.4–1.5)	0.6 (0.3–1.0)
NH Black	3.4 (3.0–4.0)	**1.7 (1.3–2.2)**	2.8 (2.4–3.3)	**2.0 (1.5–2.5)**
NH Native Hawaiian or Other Pacific Islander	3.8 (2.2–6.6)	**1.9 (1.1–3.3)**	3.0 (0.5–15.5) *	2.1 (0.4–11.5) *
NH, > 1 race	2.2 (1.5–3.0)	1.1 (0.7–1.5)	1.9 (1.4–2.7)	1.3 (0.9–2.0)
NH White	1.6 (1.5–1.8)	**0.8 (0.7–0.9)**	0.9 (0.8–1.1)	**0.6 (0.5–0.8)**
Educational Attainment				
< High school	2.8 (2.4–3.3)	**3.6 (2.5–5.3)**	2.2 (1.8–2.7)	**4.1 (2.5–6.9)**
High school	2.5 (2.2–2.9)	**3.2 (2.3–4.6)**	1.6 (1.4–1.8)	**3.0 (1.9–4.8)**
Some college	1.6 (1.5–1.9)	**2.1 (1.5–3.0)**	1.3 (1.1–1.5)	**2.4 (1.5–3.8)**

Table 3 (*continued*)

Sociodemographic characteristics, any mental illness, substance use, use frequency, and substance use disorders	Males		Females	
	Adjusted prevalence (95 % CI)	Adjusted prevalence ratio (95 % CI)	Adjusted prevalence (95 % CI)	Adjusted prevalence ratio (95 % CI)
College graduate +	0.8 (0.6–1.1)	1.0	0.5 (0.3–0.7)	1.0
Marital Status				
Married +	1.8 (1.4–2.3)	1.0	1.0 (0.8–1.3)	1.0
Divorced/Separated	2.1 (1.4–3.0)	1.2 (0.8–1.8)	1.6 (1.1–2.2)	**1.5 (1.0–2.3)**
Never married	2.0 (1.9–2.1)	1.1 (0.9–1.5)	1.4 (1.2–1.5)	**1.3 (1.0–1.8)**
Other	4.9 (3.0–7.9)	**2.8 (1.6–4.8)**	1.6 (0.7–3.7)	1.6 (0.6–4.0)
Metropolitan Statistical Area (MSA)				
Large MSA	1.9 (1.7–2.1)	**0.8 (0.6–0.9)** [A]	1.3 (1.2–1.5)	1.1 (0.9–1.4) [A]
Small MSA	1.9 (1.7–2.2)	**0.8 (0.6–0.9)** [A]	1.4 (1.2–1.6)	1.1 (0.9–1.5) [A]
Non-MSA +	2.4 (2.1–2.9)	1.0	1.2 (1.0–1.5)	1.0
Any Mental Illness (Excluding Substance Use Disorder)				
Yes	3.4 (3.0–3.9)	**2.2 (1.9–2.6)** [A]	2.3 (2.0–2.6)	**3.1 (2.5–3.8)** [A]
No +	1.5 (1.4–1.7)	1.0	0.7 (0.6–0.9)	1.0
Nicotine Dependence				
No PY cigarette use +	1.6 (1.4–1.8)	1.0	1.1 (0.9–1.2)	1.0
PY cigarette use, but no PM cigarette use	1.8 (1.5–2.2)	1.1 (0.9–1.5)	1.4 (1.0–1.8)	1.3 (1.0–1.7)
PM cigarette use, no PM nicotine dependence	2.3 (1.9–2.6)	**1.4 (1.1–1.8)**	1.2 (1.0–1.5)	1.1 (0.9–1.4)
PM cigarette use, PM nicotine dependence	2.8 (2.4–3.2)	**1.8 (1.4–2.2)**	2.2 (1.8–2.6)	**2.0 (1.6–2.6)**
Alcohol Use, Use Frequency, and Use Disorder				
No use +	1.6 (1.3–2.0)	1.0	1.2 (1.0–1.6)	1.0
Used <300 days, had no alcohol use disorder	1.6 (1.4–1.8)	1.0 (0.8–1.3)	1.2 (1.0–1.3)	0.9 (0.7–1.2)
Used ≥300 days, had no alcohol use disorder	2.1 (1.2–3.6)	1.3 (0.7–2.4)	1.5 (0.7–3.1)	1.2 (0.6–2.4)
Used <300 days, had alcohol use disorder	3.8 (3.4–4.4)	**2.4 (1.8–3.2)**	2.2 (1.8–2.8)	**1.8 (1.3–2.5)**
Used ≥300 days, had alcohol use disorder	4.7 (3.2–6.9)	**2.9 (1.8–4.7)**	1.8 (1.0–3.3)	1.5 (0.7–2.9)
Methamphetamine Use, Use Frequency, and Use Disorder				
No Use +	2.0 (1.8–2.1)	1.0	1.3 (1.1–1.4)	1.0
Used <50 days, had no	1.7 (0.9–3.2)	0.9 (0.4–1.7) [A]	3.6 (2.1–6.2)	**2.9 (1.6–5.0)** [A]

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Table 3 (*continued*)

Sociodemographic characteristics, any mental illness, substance use, use frequency, and substance use disorders	Males		Females	
	Adjusted prevalence (95 % CI)	Adjusted prevalence ratio (95 % CI)	Adjusted prevalence (95 % CI)	Adjusted prevalence ratio (95 % CI)
methamphetamine use disorder				
Used ≥50 days, had no methamphetamine use disorder	3.5 (1.2–9.9)	1.8 (0.6–5.3)	1.9 (0.4–8.5) *	1.5 (0.3–7.1) *
Used <50 days, had methamphetamine use disorder	2.2 (0.8–5.7)	1.1 (0.4–3.1)	3.0 (1.2–7.3)	**2.4 (1.0–5.9)**
Used ≥50 days, had methamphetamine use disorder	4.2 (2.5–6.8)	**2.1 (1.3–3.6)**	4.4 (2.9–6.8)	**3.5 (2.2–5.6)**
Cocaine Use, Use Frequency, and Use Disorder				
No Use +	2.0 (1.8–2.1)	1.0	1.3 (1.2–1.4)	1.0
Used <50 days, had no cocaine use disorder	1.9 (1.4–2.6)	1.0 (0.7–1.4)	1.5 (1.0–2.1)	1.1 (0.8–1.6)
Used ≥50 days, had no cocaine use disorder	1.3 (0.7–2.5)	0.7 (0.3–1.3)	1.8 (1.0–3.2)	1.4 (0.7–2.6)
Used <50 days, had cocaine use disorder	2.1 (1.1–4.0)	1.1 (0.5–2.1)	2.3 (1.3–4.3)	1.8 (0.9–3.5)
Used ≥50 days, had cocaine use disorder	3.9 (2.1–7.1)	**2.0 (1.0–3.7)**	2.4 (1.2–4.9)	1.9 (0.9–3.9)
Rx Opioid Misuse, Misuse Frequency, and Use Disorder				
No PY misuse +	1.9 (1.8–2.1)	1.0	1.2 (1.1–1.4)	1.0
PY misuse, but no PM misuse, no Rx opioid use disorder	2.3 (1.8–3.0)	1.2 (0.9–1.6)	2.1 (1.6–2.7)	**1.7 (1.3–2.2)**
PM misused <6 days, no Rx opioid use disorder	3.1 (2.0–4.6)	**1.6 (1.0–2.5)**	1.6 (1.0–2.4)	1.3 (0.8–2.0)
PM misused ≥6 days, no Rx opioid use disorder	1.3 (0.6–2.7)	0.7 (0.3–1.4) [A]	2.4 (1.3–4.3)	**2.0 (1.1–3.6)** [A]
PY misuse, but no PM misuse, had Rx opioid use disorder	1.7 (1.1–2.8)	0.9 (0.5–1.4)	1.6 (0.9–3.0)	1.4 (0.7–2.5)
PM misused <6 days, had Rx opioid use disorder	2.4 (1.1–4.9)	1.2 (0.6–2.6)	1.7 (0.8–3.6)	1.4 (0.6–3.0)
PM misused ≥6 days, had Rx opioid use disorder	2.2 (1.1–4.4)	1.1 (0.6–2.3)	3.6 (2.0–6.6)	**3.0 (1.6–5.6)**
Rx Stimulant Misuse, Misuse Frequency, and Use Disorder				
No PY misuse +	1.9 (1.8–2.1)	1.0	1.4 (1.3–1.6)	1.0
PY misuse, but no PM misuse, no Rx stimulant use disorder	2.3 (1.8–3.0)	1.2 (1.0–1.6) [A]	0.8 (0.5–1.4)	0.6 (0.3–1.0) [A]
PM misused <6 days, no Rx stimulant use disorder	2.5 (1.6–3.9)	1.3 (0.8–2.1) [A]	0.8 (0.5–1.3)	0.6 (0.3–1.0) [A]
PM misused ≥6 days, no Rx stimulant use disorder	2.8 (1.2–6.6)	1.5 (0.6–3.5)	1.7 (0.7–4.2)	1.2 (0.5–3.0)
Rx stimulant use disorder	2.0 (1.2–3.5)	1.0 (0.6–1.8) [A]	0.6 (0.2–1.3)	**0.4 (0.2–0.9)** [A]
Rx Tranquilizer Misuse, Misuse Frequency, and Use Disorder				
No PY misuse +	1.9 (1.8–2.0)	1.0	1.3 (1.2–1.4)	1.0
PY misuse, but no PM misuse, no Rx tranquilizer use disorder	2.4 (1.8–3.1)	1.3 (0.9–1.7)	1.7 (1.2–2.4)	1.3 (0.9–1.9)
PM misused <6 days, no Rx tranquilizer use disorder	3.4 (2.0–5.6)	**1.8 (1.0–3.1)**	1.0 (0.4–2.4)	0.7 (0.3–1.8)
PM misused ≥6 days, no Rx tranquilizer use disorder	3.4 (2.1–5.4)	**1.8 (1.1–2.9)**	2.0 (1.0–4.1)	1.5 (0.7–3.2)
Rx tranquilizer use disorder	3.4 (2.3–5.0)	**1.8 (1.2–2.7)**	1.5 (0.9–2.5)	1.2 (0.7–1.9)

Data source: 2015–2019 National Surveys on Drug Use and Health. Rx=Prescription; PY=Past year; PM=Past month. Family income; heroin use and use disorder; hallucinogen use, use frequency, and use disorder; and prescription sedative use, misuse use frequency, and use disorder were not significantly associated with the outcome and were not included in the final multivariable logistic regression model and the stratified models. *: Estimate with low statistical precision, caution is needed when interpreting it. [A]: Adjusted prevalence ratios differed significantly ($P < .05$) by sex within the same variable category (in the same row).

use disorder and among females with methamphetamine use regardless of methamphetamine use frequency and use disorder. The statistical power is limited for adults who used methamphetamine for ≥50 days and did not have methamphetamine use disorder in the past year because most people who used methamphetamine for ≥50 days had the disorder. People with methamphetamine use can experience neurotoxic damage, which is associated with cognitive impairment and increases in impulsivity and hostility (Kleissl-Muir et al., 2018; Mizoguchi & Yamada, 2019). People with methamphetamine use or use disorder are at higher risk of psychotic symptoms (including paranoia or psychosis) and withdrawal symptoms, which have been linked to aggression and violence (Kleissl-Muir et al., 2018; Stepjanović et al., 2023). While common factors may predispose to both violence and methamphetamine use, differences in associations for males and females suggest that the psychopharmacological effects of methamphetamine may reduce the threshold for violent behavior among females more than among males.

Although the relationship between alcohol and violence is well-established (Kuypers et al., 2020; Stepjanović et al., 2023), our study reveals further detailed sex differences in the associations between violent behavior and alcohol use, use frequency, and alcohol use disorder. We identified elevated prevalence of violent behavior among males with alcohol use disorder and among females with the disorder but without daily alcohol use. Similarly, research has shown mixed findings on opioid misuse and violence (Stepjanović et al., 2023). Our study finds that for both males and females, heroin use and use disorder are not associated with violent behavior. However, we observed elevated

prevalence of violent behavior among females with frequent prescription opioid misuse regardless of prescription opioid use disorder status and among males with infrequent prescription opioid misuse and without the disorder.

Limitations

First, the cross-sectional nature of NSDUH data allowed us to identify associations between cannabis use frequency, CUD, and violent behavior by sex but does not allow us to clarify directionality or to establish causality. We found that for both males and females during 2015–2019, the highest prevalence of adjusted violent behavior was in 2015, although the prevalence of cannabis use, daily cannabis use, and CUD was consistently higher in 2019 than in 2015 (results not shown but available upon request). These results indicate the involvement of additional contributory factors not collected by NSDUH to violent behavior. Future comprehensive research based on longitudinal study designs is needed to determine the complex relationships between violent behavior and cannabis use frequency and CUD overall and by sex. Second, we may underestimate the prevalence of substance use and SUD because NSDUH excluded people experiencing homelessness not living in shelters and institutionalized populations (e.g., jail and prison populations) who may have high substance use and SUD. Third, NSDUH reporting is subject to recall and social-desirability biases. People may be less likely to report that they attacked people with intent to harm seriously in the past year. Thus, this study may underestimate the true relationships between cannabis use/CUD and violence. Fourth, we could not examine the number of times that a young adult uses cannabis on an average day nor the amounts of cannabis consumed on an average day in the past year due to the lack of these measures in NSDUH data. Fifth, attacking people with intent to harm seriously is one type of violent behavior, and the reliability and validity of the single-item study outcome are not publicly available. We previously reported associations between cannabis use and suicidality among young adults (Han et al., 2021b).

Conclusions

Research is needed to elucidate whether causal linkages underlie the relationships between cannabis use, use frequency, and CUD and violent behavior and to investigate related sex differences during a time of evolving patterns of cannabis consumption. While our findings suggest the need for further research to understand potential explanations for the associations between violence and cannabis use, use frequency, and CUD, and for the sex differences, these results point to complex interrelationships between them and other drug use patterns and highlight the importance of early screening for and treatments of CUD, including sex-specific interventions.

CRediT authorship contribution statement

Nora D. Volkow: Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Investigation, Conceptualization. **Wilson M. Compton:** Writing – review & editing, Supervision, Methodology, Investigation, Conceptualization. **Carlos Blanco:** Writing – review & editing, Methodology, Conceptualization. **Emily B. Einstein:** Writing – review & editing, Supervision, Conceptualization. **Beth Han:** Writing – review & editing, Writing – original draft, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

Unrelated to the submitted work, Compton reports ownership of stock in General Electric Co., 3M Co., and Pfizer Inc. Drs. Volkow. Blanco, Einstein, and Han have no conflicts to disclose.

Disclaimers

The findings and conclusions of this study are those of the authors and do not necessarily reflect the views of the National Institute on Drug Abuse of the National Institutes of Health and the U.S. Department of Health and Human Services.

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