



Prevalence of and trends in current cannabis use among US youth and adults, 2013–2022

Delvon T. Mattingly^{a,b,*}, Maggie K. Richardson^c, Joy L. Hart^{d,e,f}

^a Department of Behavioral Science, College of Medicine, University of Kentucky, Lexington, KY 40536, USA

^b Center for Health Equity Transformation, College of Medicine, University of Kentucky, Lexington, KY 40536, USA

^c Department of Educational, School, & Counseling Psychology, College of Education, University of Kentucky, Lexington, KY 40506, USA

^d Department of Communication, College of Arts and Sciences, University of Louisville, Louisville, KY 40292, USA

^e Christina Lee Brown Envirome Institute, School of Medicine, University of Louisville, Louisville, KY 40202, USA

^f American Heart Association Tobacco Center for Regulatory Science, Dallas, TX 75231, USA

HIGHLIGHTS

- The prevalence of cannabis use increased from 2013 to 2019 and 2021–2022.
- Cannabis use among youth did not change significantly across the study period.
- Multiracial and low-SES respondents had high prevalence of use at all time points.
- From 2021–2022, cannabis use increased among male and female respondents.
- Cannabis use also increased among Hispanic, White, and higher-SES respondents.

ARTICLE INFO

Keywords:
Cannabis
Marijuana
Substance use
Health disparities
Epidemiology
NSDUH

ABSTRACT

Introduction: Cannabis use is increasing due to several factors including the adoption of laws legalizing its use across the United States (US). We examined changes in current cannabis use among US youth and adults and by key sociodemographic groups.

Methods: Using data from the 2013–2022 National Survey on Drug Use and Health (n=543,195), we estimated the prevalence of (2013–2019, 2020, 2021–2022) and trends in (2013–2019, 2021–2022) current (i.e., past 30-day) cannabis use among US youth (aged 12–17) and adults (aged 18+) overall and by age, gender, race and ethnicity, educational attainment, and total annual family income. We also examined sociodemographic factors associated with use from 2013 to 2019, in 2020, and from 2021 to 2022.

Results: Cannabis use increased from 7.59 % to 11.48 % in 2013–2019, was 11.54 % in 2020, and increased again from 13.13 % to 15.11 % in 2021–2022. Among youth, cannabis use remained constant from 2013 to 2019 and 2021–2022. In 2022, use was highest among aged 18–34, male, non-Hispanic multiracial, and generally lower SES adults. From 2021–2022, cannabis use increased among several groups such as adults who were aged 35–49 (14.25–17.23 %), female (11.21–13.00 %), and Hispanic (10.42–13.50 %). Adults who were aged 18–25, male, non-Hispanic multiracial, some college educated, and of lower annual family income had consistently higher odds of current cannabis use from 2013 to 2019, in 2020, and from 2021 to 2022.

Conclusions: Cannabis use is increasing overall and among certain sociodemographic groups. Our findings inform prevention and harm reduction efforts aimed at mitigating the prevalence of cannabis use in the US.

1. Introduction

Approximately 200 million people use cannabis worldwide (Shao et al., 2023). Given increases in cannabis use disorders, cannabis use is

considered a contributor to global disease prevalence (Shao et al., 2023). In the United States (US), cannabis remains the most used psychoactive substance despite shifting views of its social acceptability and perceived harm (Gali et al., 2021; Hasin, 2018; Substance Abuse and Mental

* Corresponding author at: Department of Behavioral Science, College of Medicine, University of Kentucky, Lexington, KY 40536, USA.

E-mail address: delvonmattingly@uky.edu (D.T. Mattingly).

<https://doi.org/10.1016/j.dadr.2024.100253>

Received 30 March 2024; Received in revised form 13 June 2024; Accepted 27 June 2024

Available online 28 June 2024

2772-7246/© 2024 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Health Services Administration, 2023). In 2022, 61.9 million people (22.0 %) reported using cannabis in the past year, while 42.3 million people (15.0 %) used cannabis in the past 30 days (i.e., current use), with use prevalence increasing over time (Compton et al., 2016; Hasin and Walsh, 2021; Palamar et al., 2021; Substance Abuse and Mental Health Services Administration, 2023). These increases are partially due to more states legalizing recreational and medical cannabis, as well as decriminalizing its possession and use (Farrelly et al., 2023; Lapham et al., 2023; Smart and Pacula, 2019).

Although cannabis use may provide potential health benefits, its adverse effects remain a concern (Connor et al., 2021; Hasin, 2018; Hasin and Walsh, 2020; National Academies of Sciences, Engineering, and Medicine., 2017). These effects include, but are not limited to, the development of cannabis use disorders, psychiatric comorbidity (e.g., psychosis, psychotic disorder, schizophrenia, anxiety disorders and panic attacks), use of other substances such as tobacco and illicit drugs, prenatal or unintentional youth exposure, developmental delays, impaired driving, and memory issues (Connor et al., 2021; Hasin, 2018; Hasin and Walsh, 2020; National Academies of Sciences, Engineering, and Medicine., 2017; Rabiee et al., 2020). Because certain demographic groups in the US have a higher prevalence of cannabis use (e.g., young adults, males, and racial and ethnic minoritized groups), they may be at higher risk for negative health effects (Substance Abuse and Mental Health Services Administration, 2023). Thus, understanding use trends overall and by demographic groups is important in examining prevalence and changes.

Although the coronavirus disease (COVID-19) pandemic presented challenges in surveying the health status of US youth and adults in 2020 (Uleanya and Yu, 2023), limiting the ability to precisely estimate behavioral health differences over time (Center for Behavioral Health Statistics and Quality, 2021, 2022, 2023; Uleanya and Yu, 2023), it remains important to leverage epidemiological data to assess changes in behavior and health. Several estimations of cannabis use trends occurred prior to the start of the COVID-19 pandemic (Hasin and Walsh, 2021; Keyes et al., 2022; Palamar et al., 2021), and pandemic experiences may have impacted subsequent use behaviors. Therefore, this study aims to extend prior work by providing nationally representative estimates of cannabis use for US youth and adults overall and by age, gender, race and ethnicity, and socioeconomic status (SES) from 2013 to 2022, separated into three critical periods: (1) pre-COVID-19 (2013–2019), (2) the year the COVID-19 pandemic introduced methodological challenges to data collection (2020), and (3) during the COVID-19 pandemic (2021–2022).

2. Methods

2.1. Data and participants

We used data from the 2013–2022 National Survey on Drug Use and Health (NSDUH), a nationally representative, repeated cross-sectional survey of noninstitutionalized US civilians ages 12 years or older (Center for Behavioral Health Statistics and Quality, 2014, 2015, 2016, 2017a, 2018, 2019, 2020, 2022, 2023a, 2023b). The NSDUH uses a multistage, stratified sampling method to recruit participants every quarter and assess information about their drug use and mental health via in-person computer-assisted self-administered or interviewer-administered questionnaires (Center for Behavioral Health Statistics and Quality, 2021). Beginning in quarter 4 of 2020, the NSDUH introduced multimodal data collection offering both in-person and web-based surveys due to shifts in protocol caused by the COVID-19 pandemic (Center for Behavioral Health Statistics and Quality, 2021). Due to limited data collection in early 2020 and changes to data collection methods in late 2020, it is inadvisable to compare estimates from 2020 with prior or subsequent years (Center for Behavioral Health Statistics and Quality, 2021). Similarly, data from 2021 and 2022 are not directly comparable to previous years as mode of data collection

has been found to influence estimates (Center for Behavioral Health Statistics and Quality, 2022, 2023a, 2023b). Given these considerations, we observe trends between 2013–2019 and 2021–2022, and we introduce trend breaks between 2019 and 2020 as well as between 2020 and 2021. Additional details about the NSDUH, including interview content and sampling methodology, are available online (Center for Behavioral Health Statistics and Quality, 2023b).

Our sample included youth (aged 12–17 years) and adults (aged 18+ years) who completed a survey from 2013 to 2022 and had complete information on sociodemographic characteristics and cannabis use (n=543,195). Given that NSDUH study investigators perform imputation methods to replace respondent missing data with valid, non-missing data (Center for Behavioral Health Statistics and Quality, 2017b), our analysis contains no missing values.

2.2. Measures

We defined current cannabis use as self-reported past 30-day use (yes/no). The following sociodemographic characteristics were included in this analysis: age (12–17, 18–25, 26–34, 35–49, 50–64, 65+ years), gender (male, female), race and ethnicity (Hispanic, non-Hispanic White, non-Hispanic Black, non-Hispanic multiracial, another non-Hispanic race), educational attainment (less than high school degree, high school graduate/GED, some college/Associate degree, college graduate or more), and total annual family income (less than \$20,000; \$20,000 to \$49,999; \$50,000 to \$74,999, \$75,000+).

2.3. Statistical analysis

We calculated yearly (2013–2022) weighted prevalence of current cannabis use overall and by age, gender, race and ethnicity, educational attainment, and total annual family income. For educational attainment, we examined only adults who were aged 26 or older (n=277,802) to allow time for college completion. We assessed changes over time (2013–2019, 2021–2022) and associated sociodemographic disparities by examining confidence interval overlap (two-sided, significance level <0.05). Using multivariable logistic regression, we tested for linear trends in current cannabis use with year included as a continuous variable overall and for each sociodemographic subgroup from 2013 to 2019 and from 2021 to 2022, and we report these p-values alongside changes in weighted prevalence. We also conducted multivariable logistic regression to examine sociodemographic characteristics associated with cannabis use from 2013 to 2019, in 2020, and from 2021 to 2022 separately. All analyses were conducted using Stata 18.0 and were adjusted for the complex survey design of NSDUH and probability of participant nonresponse using survey weights.

3. Results

3.1. Participant characteristics

Nearly 55,000 youth and adults participated in the NSDUH each year except 2020 when approximately 33,000 responded (Supplementary Table 1). A higher proportion of the sample was 50–64 (22.80 %) followed by 35–49 (22.46 %), 65+ (18.50 %), 26–34 (14.43 %), 18–25 (12.59 %), and 12–17 (9.21 %) years old. The sample contained more female (51.42 %) than male (48.58 %) respondents. A higher proportion identified as non-Hispanic White (62.64 %) followed by Hispanic (16.90 %) and non-Hispanic Black (12.06 %). Among adults aged 26 or older, 34.01 % had college educations and 28.40 % had some college/Associate degree. Among the respondents, 38.06 % earned \$75,000 or more in annual family income, followed by \$20,000 to \$49,999 (29.06 %) and less than \$20,000 (16.46 %). Finally, about one-tenth currently used cannabis (10.45 %).

3.2. Current cannabis use (2013–2019)

3.2.1. Prevalence of and trends in use

From 2013–2019, current cannabis use increased from 7.59 % to 11.48 % ($p < 0.001$) (Table 1, Fig. 1). For age, cannabis use remained constant among youth 12–17 (7.11–7.59 %, $p=0.98$) and increased among adults 18–25 (19.47–23.03 %, $p < 0.001$), 26–34 (12.54–18.94 %, $p < 0.001$), 35–49 (5.88–11.41 %, $p < 0.001$), 50–64 (4.33–8.88 %, $p < 0.001$), and 65+ (1.09–3.38 %, $p < 0.001$) years old. Cannabis use also increased for both male (9.74–13.97 %, $p < 0.001$) and female (5.56–9.13 %, $p < 0.001$) respondents.

For race and ethnicity, cannabis use increased among Hispanic (6.31–9.67 %, $p < 0.001$), non-Hispanic White (7.76–11.95 %, $p < 0.001$), non-Hispanic Black (8.99–13.72 %, $p < 0.001$), and non-Hispanic multiracial respondents (16.62–19.72 %, $p=0.005$), as well as respondents who identified as another non-Hispanic race (3.86–5.33 %, $p < 0.001$).

For adults aged 26 or older, cannabis use significantly increased among those who had less than a high school degree (6.40–8.86 %, $p < 0.001$), completed high school/GED (6.01–10.48 %, $p < 0.001$), some college/Associate degree (6.18–12.63 %, $p < 0.001$), and a college degree or more (4.48–8.26 %, $p < 0.001$). For annual family income, cannabis use increased among respondents who made less than \$20,000/year (11.25–15.46 %, $p < 0.001$), and these adults had consistently higher prevalence of cannabis use than respondents reporting other income levels. In addition, cannabis use increased for adults with \$20,000 to \$49,999 (7.83–11.88 %, $p < 0.001$), \$50,000 to \$74,999 (6.51–11.64 %, $p < 0.001$), and \$75,000 or more (5.89–9.71 %, $p < 0.001$) in annual family income.

3.2.2. Associated sociodemographic factors

Increasing year (2013–2019) was associated with cannabis use (adjusted odds ratio (AOR): 1.09, 95 % confidence interval (CI): 1.08–1.10). Compared to respondents aged 18–25 years, every other age group was associated with lower odds of cannabis use (e.g., AOR: 0.72, 95 % CI: 0.69–0.74 for adults aged 26–34 years). Female (vs. male) gender was associated with lower odds of cannabis use (AOR: 0.57, 95 % CI: 0.55–0.59). Compared to non-Hispanic White, Hispanic, non-Hispanic Black, and another non-Hispanic race or ethnicities were associated with lower odds of cannabis use, while non-Hispanic multiracial was associated with higher odds of use (AOR: 1.51, 95 % CI: 1.39–1.65). Completing some college/Associate degree educational attainment was associated with higher odds of cannabis use (AOR: 1.19, 95 % CI: 1.12–1.26), and college graduate or more was associated with lower odds (AOR: 0.88, 95 % CI: 0.82–0.95), as compared to less than high school degree. Furthermore, each level of annual family income, compared to less than \$20,000, was associated with lower odds of cannabis use.

3.3. Current cannabis use (2020)

3.3.1. Prevalence of use

In 2020, the overall prevalence of current cannabis use was 11.54 % (Table 2, Fig. 1). It was higher for respondents aged 18–25 years (23.38 %) and 26–34 years (18.26 %). A higher proportion of male (13.05 %) than female (10.13 %) respondents used cannabis. Non-Hispanic multiracial (20.28 %), non-Hispanic Black (13.73 %), and non-Hispanic White (12.26 %) respondents had a higher prevalence of cannabis use than Hispanic (8.82 %) respondents and those who identified as another non-Hispanic race (5.83 %). Cannabis use was more prevalent among adults who had completed some college/Associate degree (12.13 %) and high school/GED (11.46 %) than other educational attainment categories. For annual family income, respondents with less than \$20,000 (15.80 %) had a higher prevalence of use than those with \$50,000 to \$74,999 (10.31 %) or \$75,000 or more (9.35 %).

3.3.2. Associated sociodemographic factors

In the multivariable logistic regression model, use by all age groups, compared to respondents aged 18–25 years, was associated with lower odds of cannabis use. Female gender (vs. male) (AOR: 0.73, 95 % CI: 0.65–0.83) and, compared to non-Hispanic White, Hispanic (AOR: 0.52, 95 % CI: 0.42–0.65) and another non-Hispanic race (OR: 0.38, 95 % CI: 0.30–0.48) were associated with lower odds of use as well. Both high school graduate/GED (AOR: 1.46, 95 % CI: 1.18–1.80) and some college/Associate degree (AOR: 1.62, 95 % CI: 1.28–2.04) educational attainment, compared to less than high school degree, were associated with higher odds of cannabis use. For annual family income, \$50,000 to \$74,999 (AOR: 0.60, 95 % CI: 0.49–0.74) and \$75,000 or more (AOR: 0.55, 95 % CI: 0.44–0.68) were associated with lower odds of cannabis use, compared to less than \$20,000.

3.4. Current cannabis use (2021–2022)

3.4.1. Prevalence of and trends in use

Current cannabis use increased from 2021 (13.13 %) to 2022 (15.11 %) ($p < 0.001$) (Table 3, Fig. 1). It remained constant for youth 12–17 years (6.07–6.32 %, $p=0.62$) and adults 18–25 (24.76–26.16 %, $p=0.11$) and 65+ (4.79–5.16 %, $p=0.63$) years old. However, cannabis use increased significantly among adults aged 26–34 (22.04–25.46 %, $p=0.003$), 35–49 (14.25–17.23 %, $p < 0.001$), and 50–64 (10.38–12.82 %, $p=0.015$) years old. In terms of gender, cannabis use increased among both male (15.13–17.31 %, $p=0.004$) and female (11.21–13.00 %, $p < 0.001$) respondents.

In 2021 and 2022, cannabis use was higher among non-Hispanic multiracial respondents (21.72 % and 25.14 %, $p=0.24$) compared to all other racial or ethnic groups but did not statistically significantly increase. Furthermore, cannabis use prevalence increased among Hispanic (10.42–13.50 %, $p=0.009$) and non-Hispanic White (13.80–15.88 %, $p < 0.001$) but not non-Hispanic Black (15.00–16.19 %, $p=0.22$) respondents or respondents who identified as another non-Hispanic race (8.34–7.83 %, $p=0.84$).

For adults 26 years or older, cannabis use increased among respondents who had completed high school/GED (11.95–14.80 %, $p < 0.001$) and college degree or more (9.94–12.42 %, $p < 0.001$) but not among respondents who had less than a high school degree (10.44–11.47 %, $p=0.53$) and some college/Associate degree (15.80–17.42 %, $p=0.14$). For annual family income, cannabis use increased among adults who reported less than \$20,000 (16.15–18.91 %, $p=0.026$), \$50,000 to \$74,999 (12.89–15.65 %, $p=0.013$), and \$75,000 or more (10.37–13.20 %, $p < 0.001$) but not among adults who reported \$20,000 to \$49,999 (15.36–15.81 %, $p=0.24$). In addition, adults earning less than \$20,000 had higher cannabis use prevalence in 2022 (18.91 %) compared to all other income levels.

3.4.2. Associated sociodemographic factors

Increasing year (2021–2022) was associated with cannabis use (AOR: 1.21, 95 % CI: 1.13–1.30). Compared to respondents aged 18–25 years, respondents aged 12–17, 50–64, and 65+ years had lower odds of cannabis use. Female (vs. male) gender was associated with lower odds of cannabis use, as was being Hispanic (AOR: 0.59, 95 % CI: 0.54–0.65), non-Hispanic Black (AOR: 0.84, 95 % CI: 0.77–0.92), and another non-Hispanic race (AOR: 0.44, 95 % CI: 0.36–0.54) (vs. non-Hispanic White). In addition, non-Hispanic multiracial race (vs. non-Hispanic White) was associated with higher odds of cannabis use (AOR: 1.43, 95 % CI: 1.17–1.74). For educational attainment, some college/Associate degree, compared to less than high school degree, was associated with higher odds of cannabis use (AOR: 1.36, 95 % CI: 1.23–1.51). Lastly, \$50,000 to \$74,999 (AOR: 0.78, 95 % CI: 0.70–0.86) and \$75,000 or more (AOR: 0.62, 95 % CI: 0.57–0.68) annual income, compared to less than \$20,000, were associated with lower odds of cannabis use.

Table 1
Weighted prevalence of current cannabis use overall and by sociodemographic characteristics among US youth and adults, 2013–2019 (n=393,199).

	Year, % (95 % CI)							P for trend ^a	AOR (95 % CI) ^b
	2013 (n=55,160)	2014 (n=55,271)	2015 (n=57,146)	2016 (n=56,897)	2017 (n=56,276)	2018 (n=56,313)	2019 (n=56,136)		
Overall	7.59 (7.20, 8.00)	8.50 (8.27, 8.74)	8.32 (7.93, 8.73)	8.80 (8.50, 9.11)	9.47 (9.08, 9.88)	10.10 (9.72, 10.50)	11.48 (11.09, 11.87)	<0.001	1.09 (1.08, 1.10)
Age									
12–17 years	7.11 (6.62, 7.62)	7.39 (6.85, 7.97)	7.09 (6.55, 7.67)	6.35 (5.91, 6.83)	6.58 (6.05, 7.15)	6.61 (6.03, 7.25)	7.59 (6.99, 8.25)	0.98	0.32 (0.30, 0.33)
18–25 years	19.47 (18.55, 20.42)	19.95 (18.94, 21.00)	20.12 (19.20, 21.08)	20.71 (19.92, 21.53)	21.62 (20.72, 22.55)	22.03 (21.06, 23.02)	23.03 (22.03, 24.06)	<0.001	REF
26–34 years	12.54 (11.45, 13.72)	12.67 (11.67, 13.75)	12.98 (12.15, 13.85)	14.48 (13.42, 15.61)	14.94 (13.97, 15.95)	16.78 (15.92, 17.67)	18.94 (18.03, 19.88)	<0.001	0.72 (0.69, 0.74)
35–49 years	5.88 (5.22, 6.61)	7.66 (7.11, 8.26)	7.10 (6.40, 7.85)	7.97 (7.41, 8.57)	8.93 (8.21, 9.71)	10.26 (9.49, 11.07)	11.41 (10.59, 12.28)	<0.001	0.39 (0.38, 0.41)
50–64 years	4.33 (3.58, 5.24)	5.92 (5.15, 6.81)	5.87 (5.12, 6.73)	5.51 (4.73, 6.41)	6.65 (5.90, 7.50)	6.81 (6.00, 7.73)	8.88 (7.96, 9.89)	<0.001	0.26 (0.25, 0.28)
65+ years	1.09 (0.60, 1.96)	1.41 (1.07, 1.87)	1.22 (0.78, 1.90)	2.22 (1.63, 3.01)	2.42 (1.95, 2.99)	2.51 (1.80, 3.48)	3.38 (2.75, 4.14)	<0.001	0.08 (0.07, 0.09)
Gender									
Male	9.74 (9.18, 10.34)	11.03 (10.63, 11.44)	10.50 (9.88, 11.16)	11.17 (10.63, 11.74)	11.74 (11.08, 12.44)	12.29 (11.71, 12.89)	13.97 (13.39, 14.57)	<0.001	REF
Female	5.56 (5.06, 6.11)	6.13 (5.80, 6.48)	6.28 (5.91, 6.66)	6.57 (6.23, 6.92)	7.33 (6.87, 7.82)	8.04 (7.54, 8.58)	9.13 (8.60, 9.69)	<0.001	0.57 (0.55, 0.59)
Race and ethnicity ^c									
Hispanic	6.31 (5.55, 7.18)	6.62 (5.93, 7.38)	7.21 (6.55, 7.94)	7.45 (6.57, 8.44)	8.13 (7.38, 8.94)	8.56 (7.71, 9.50)	9.67 (8.87, 10.52)	<0.001	0.57 (0.54, 0.59)
Non-Hispanic White	7.76 (7.31, 8.23)	8.90 (8.55, 9.26)	8.42 (7.92, 8.95)	8.89 (8.50, 9.31)	9.78 (9.30, 10.27)	10.20 (9.78, 10.64)	11.95 (11.41, 12.52)	<0.001	REF
Non-Hispanic Black	8.99 (7.85, 10.27)	10.61 (9.62, 11.68)	10.75 (9.82, 11.76)	11.14 (10.24, 12.12)	11.23 (10.39, 12.12)	12.48 (11.32, 13.75)	13.72 (12.72, 14.77)	<0.001	0.94 (0.89, 0.99)
Non-Hispanic multiracial	16.62 (13.03, 20.96)	12.79 (10.96, 14.87)	13.35 (11.39, 15.57)	16.83 (14.14, 19.91)	15.69 (12.96, 18.88)	17.38 (14.72, 20.40)	19.72 (16.71, 23.11)	0.005	1.51 (1.39, 1.65)
Another non-Hispanic race	3.86 (2.85, 5.21)	4.05 (3.19, 5.13)	4.20 (3.28, 5.35)	4.65 (3.91, 5.53)	5.05 (4.20, 6.06)	6.70 (5.70, 7.87)	5.33 (4.52, 6.27)	<0.001	0.40 (0.37, 0.44)
Educational attainment (ages 26+)									
Less than high school degree	6.40 (5.24, 7.80)	6.42 (5.53, 7.45)	6.03 (5.25, 6.92)	6.21 (5.32, 7.24)	7.46 (6.35, 8.73)	8.32 (7.05, 9.78)	8.86 (7.71, 10.17)	<0.001	REF
High school graduate/GED	6.01 (5.09, 7.10)	7.48 (6.75, 8.29)	6.88 (6.02, 7.85)	7.38 (6.63, 8.22)	8.37 (7.60, 9.21)	8.98 (8.17, 9.85)	10.48 (9.56, 11.46)	<0.001	1.06 (0.99, 1.12)
Some college/Associate degree	6.18 (5.31, 7.19)	8.04 (7.35, 8.78)	7.93 (7.28, 8.63)	8.68 (8.02, 9.38)	9.13 (8.46, 9.85)	9.80 (9.03, 10.62)	12.63 (11.5, 13.79)	<0.001	1.19 (1.12, 1.26)
College graduate or more	4.48 (3.79, 5.30)	5.09 (4.55, 5.68)	5.14 (4.52, 5.84)	5.95 (5.37, 6.60)	6.57 (5.92, 7.29)	7.46 (6.67, 8.33)	8.26 (7.48, 9.12)	<0.001	0.88 (0.82, 0.95)
Total annual family income									
Less than \$20,000	11.25 (10.27, 12.32)	12.25 (11.36, 13.20)	11.30 (10.50, 12.15)	11.99 (11.29, 12.73)	13.58 (12.35, 14.92)	13.58 (12.71, 14.49)	15.46 (14.52, 16.45)	<0.001	REF
\$20,000 to \$49,999	7.83 (7.07, 8.66)	9.31 (8.75, 9.90)	8.92 (8.21, 9.69)	9.56 (9.00, 10.14)	10.00 (9.39, 10.65)	10.69 (10.09, 11.31)	11.88 (11.22, 12.58)	<0.001	0.79 (0.75, 0.83)
\$50,000 to \$74,999	6.51 (5.76, 7.34)	7.23 (6.55, 7.98)	7.75 (6.96, 8.63)	7.84 (7.07, 8.69)	8.37 (7.52, 9.30)	9.58 (8.69, 10.55)	11.64 (10.67, 12.69)	<0.001	0.66 (0.62, 0.70)
\$75,000 or more	5.89 (5.32, 6.53)	6.43 (5.90, 7.00)	6.62 (6.04, 7.26)	7.16 (6.73, 7.63)	7.82 (7.26, 8.42)	8.51 (7.95, 9.10)	9.71 (9.13, 10.33)	<0.001	0.59 (0.57, 0.62)

Bolded cells indicate statistical significance at $p < 0.05$.

^a Adjusted linear test in trend of the effect of survey year on current cannabis use overall and by each sociodemographic subgroup

^b Adjusted odds ratios and 95 % confidence intervals calculated using multivariable logistic regression between survey year and each sociodemographic characteristic and current cannabis use

^c Another non-Hispanic race included respondents who identified as non-Hispanic Asian, non-Hispanic American Indian/Alaskan Native, and non-Hispanic Native Hawaiian/other Pacific Islander.

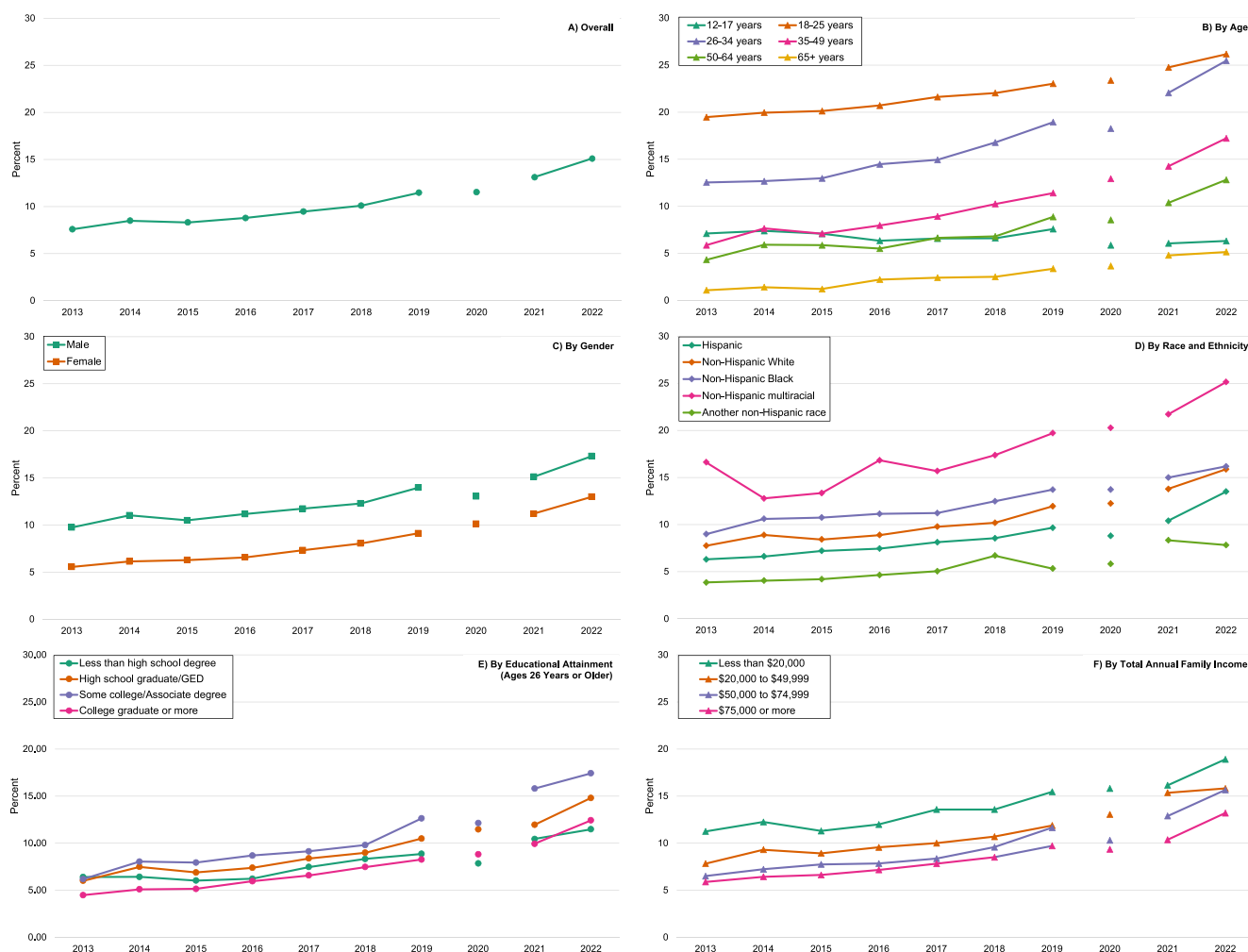


Fig. 1. Trends in current cannabis use among US youth and adults overall (a) and by age (b), gender (c), race and ethnicity (d), educational attainment (e), and total annual family income (f), 2013–2022. Footnote: Another non-Hispanic race included respondents who identified as non-Hispanic Asian, non-Hispanic American Indian/Alaskan Native, and non-Hispanic Native Hawaiian/other Pacific Islander.

4. Discussion

This study extends existing literature on cannabis use trends and associated disparities by sociodemographic characteristics. We found that cannabis use increased from 2013 to 2019 as well as from 2021 to 2022, with the prevalence in 2020 falling within this trend. We observed within-group differences in current cannabis use across time, with certain sociodemographic groups, such as younger or older adults, males and females, multiple racial and ethnic groups, and multiple SES group respondents, showing increases over time, either between 2013–2019 or 2021–2022. In addition, certain sociodemographic groups such as non-Hispanic multiracial and low-SES respondents from 2021 to 2022 did not show change in use over time but had consistently higher between-group use prevalence. In sum, our results highlight key population groups that have elevated and increased prevalence of current cannabis use across three key periods of time.

Although we cannot directly compare trends between 2013–2019 and 2021–2022, certain increases observed in the former set of years parallel those of the latter. For example, among female respondents, cannabis use increased both between 2013–2019 and 2021–2022. Consideration of this uptick may be helpful in informing public health, medical, and policy professionals committed to mitigating cannabis use and promoting harm reduction. Certain groups, such as males, had elevated prevalence of current cannabis use in 2022 and from 2021–2022, warranting similar considerations. Respondents aged 18–34

years or who identified as non-Hispanic multiracial had cannabis use prevalence of nearly 25%. These respondents may be at heightened risk for using other substances and/or developing psychiatric comorbidity (Connor et al., 2021; Hasin, 2018; Hasin and Walsh, 2020; National Academies of Sciences, Engineering, and Medicine., 2017; Rabiee et al., 2020).

The prevalence of cannabis use did not change among youth over time. While prior research involving predominantly youth samples suggests that the prevalence of cannabis use is increasing (Keyes et al., 2022) and that this uptick is correlated with increasing age (Farokhnia et al., 2024), our study provides a different perspective. Because we examined youth as one category (ages 12–17) annually, our study did not observe whether changes in current cannabis use occurred within specific age ranges (e.g., from 12 to 13 years old). However, we observed large increases from 2013–2019 and 2021–2022 in younger and older adults relative to the youth category. These increases in adults, but not youth, use may be attributed to or influenced by recent surges in legalization and decriminalization of cannabis use in the US. Previous work supports the notion that cannabis legalization/decriminalization comes with adverse health outcomes (e.g., cannabis use disorder or emergency room visits) for adults including older adults (Mody and Inouye, 2024; Smart and Pacula, 2019). In contrast, a recent national study among youth suggests that recreational cannabis laws were not associated with cannabis use (Anderson et al., 2024). Additionally, the increase in cannabis use among older adults may be attributed to using

Table 2
Weighted prevalence of current cannabis use overall and by sociodemographic characteristics among US youth and adults, 2020 (n=32,893).

	Year, % (95 % CI)	
	2020 (n=32,893)	AOR (95 % CI) ^a
Overall	11.54 (10.97, 12.14)	–
Age		
12–17 years	5.87 (4.99, 6.90)	0.33 (0.25, 0.44)
18–25 years	23.38 (21.93, 24.89)	REF
26–34 years	18.26 (16.30, 20.41)	0.80 (0.68, 0.93)
35–49 years	12.93 (11.75, 14.21)	0.55 (0.48, 0.64)
50–64 years	8.57 (7.07, 10.34)	0.32 (0.25, 0.40)
65+ years	3.67 (2.66, 5.04)	0.12 (0.09, 0.17)
Gender		
Male	13.05 (12.17, 13.98)	REF
Female	10.13 (9.36, 10.95)	0.73 (0.65, 0.83)
Race and ethnicity ^b		
Hispanic	8.82 (7.40, 10.48)	0.52 (0.42, 0.65)
Non-Hispanic White	12.26 (11.55, 13.01)	REF
Non-Hispanic Black	13.73 (11.78, 15.94)	0.87 (0.71, 1.06)
Non-Hispanic multiracial	20.28 (15.51, 26.06)	1.39 (0.95, 2.03)
Another non-Hispanic race	5.83 (4.75, 7.14)	0.38 (0.30, 0.48)
Educational attainment (ages 26+)		
Less than high school degree	7.83 (6.47, 9.44)	REF
High school graduate/GED	11.46 (10.13, 12.94)	1.46 (1.18, 1.80)
Some college/Associate degree	12.13 (10.93, 13.45)	1.62 (1.28, 2.04)
College graduate or more	8.82 (7.78, 9.99)	1.28 (1.00, 1.65)
Total annual family income		
Less than \$20,000	15.80 (14.02, 17.75)	REF
\$20,000 to \$49,999	13.06 (11.72, 14.55)	0.84 (0.68, 1.04)
\$50,000 to \$74,999	10.31 (9.02, 11.77)	0.60 (0.49, 0.74)
\$75,000 or more	9.35 (8.40, 10.40)	0.55 (0.44, 0.68)

Bolded cells indicate statistical significance at $p < 0.05$.

^a Adjusted odds ratios and 95 % confidence intervals calculated using multi-variable logistic regression between survey year and each sociodemographic characteristic and current cannabis use

^b Another non-Hispanic race included respondents who identified as non-Hispanic Asian, non-Hispanic American Indian/Alaskan Native, and non-Hispanic Native Hawaiian/other Pacific Islander.

cannabis to combat pain, nausea, and/or insomnia experienced in general or that is associated with chronic diseases (Anderson et al., 2024).

Factors associated with current cannabis use across three critical time periods (from 2013 to 2019, in 2020, from 2021 to 2022) revealed consistencies over time. For example, young adults aged 18–25 consistently had higher odds of current cannabis use compared to other age groups. Cannabis use is steady among younger adults and additional work focused on these populations to mitigate use, and associated disparities within young adult groups, is needed. Cannabis use also rose among adults aged 26–34, 35–49, and 50–64 years from 2013–2019 and 2021–2022, indicating a need to monitor use behaviors among these populations as well. For race and ethnicity, cannabis use increased among Hispanic and non-Hispanic White respondents across time from 2013–2019 and 2021–2022. Although the prevalence of use was generally not higher than their non-Hispanic Black and non-Hispanic multiracial counterparts, this rise in use, especially among Hispanic respondents, is noteworthy. Recent research has found that Hispanic youth and adults use cannabis in novel forms such as via vaping more so relative to their racial and ethnic counterparts (Mattingly et al., 2022; Watson et al., 2021), which may partly explain the uptick of use in this group.

In our study, higher annual income was consistently associated with lower odds of cannabis use across the three study time periods. However, for educational attainment, some college/Associate degree was associated with higher odds of cannabis use compared to adult counterparts who had not completed high school. These increases may correspond to upticks in use among older adult populations who may also be more educated. Further research investigating the reasons by which cannabis use is increasing among both older and educated adults is needed to understand potential drivers of these trends, especially as

the relationship between cannabis use and educational attainment is well documented, with cannabis use generally more common among less educated adults (Jeffers et al., 2021). Cannabis use is also associated with educational attainment among youth, with prior research suggesting that excessive use during youthhood may lead to decreasing educational attainment in the future (Melchior et al., 2017). The observed increase in cannabis use among individuals who completed some college/Associate degrees may represent a period or cohort effect as opposed to an age effect, as cannabis use earlier in life is associated with less favorable education outcomes later (Melchior et al., 2017). However, these theories would need to be investigated using longitudinal study designs.

Our results suggest additional efforts are needed to better understand factors leading to increases in cannabis use in the US. Although some people may use cannabis for its therapeutic effects (Leinen et al., 2023; Pagano et al., 2022), it is difficult to overlook the potential harms of use, especially among at-risk populations. Future research examining influences on cannabis use, such as recreational and medical legalization, psychiatric comorbidity trends including anxiety and depression, and cannabis-related social acceptability and perceptions of harm, is imperative. These endeavors coupled with research aimed at better understanding how the COVID-19 pandemic altered cannabis use behaviors may provide better insight into potential drivers of its use. Furthermore, research incorporating fine-grained assessments of cannabis use patterns (e.g., frequency/intensity) may help better determine populations more susceptible to the potential health effects of cannabis use.

4.1. Limitations

Our study has several limitations. First, COVID-19-related changes in NSDUH methodologies (e.g., shift to web-based interviewing in 2021) prohibited examining trends with 2020 data as well as comparing 2021 and subsequent data with previous years. We observed substantial shifts in cannabis use such as a decrease in use among youth from 2019 to 2020, but due to methodological changes in the NSDUH study design, it is difficult to determine whether these changes in use behaviors were due to methodological shifts, actual behavior, or both. Second, our analysis used repeated cross-sectional data and annual estimates of current cannabis use were calculated from different participants each year as opposed to observing repeated observations within the same individuals over time. Furthermore, some households could have participated in more than one NSDUH survey over the course of ten years, potentially biasing study estimates. Third, data were self-reported and may be subject to response biases. Fourth, since the NSDUH did not assess sexual orientation in the years 2013 and 2014, we did not include trends based on these identities. Fifth, we excluded youth and young adults aged 18–25 from prevalence and trends analyses involving educational attainment to give every respondent adequate time to have had completed college, and this analytical decision could have skewed the findings. Finally, we did not examine variation in cannabis use by state or legalization status.

5. Conclusion

Our study extends previous findings on US trends in current cannabis use among youth and adults. We found that cannabis use is increasing overall and among certain sociodemographic groups, informing prevention and harm reduction efforts that help mitigate the prevalence of cannabis use in the US. In addition, given the changing landscape in US cannabis legalization, and associated knowledge, attitudes, and beliefs about cannabis, educational campaigns are needed to address the harms associated with increased cannabis use among youth and adults.

Table 3

Weighted prevalence of current cannabis use overall and by sociodemographic characteristics among US youth and adults, 2021–2022 (n=117,103).

	Year, % (95 % CI)		P for trend ^a	AOR (95 % CI) ^b
	2021 (n=58,034)	2022 (n=59,069)		
Overall	13.13 (12.38, 13.92)	15.11 (14.58, 15.66)	<0.001	1.21 (1.13, 1.30)
Age				
12–17 years	6.07 (5.24, 7.01)	6.32 (5.72, 6.98)	0.62	0.24 (0.20, 0.27)
18–25 years	24.76 (23.18, 26.41)	26.16 (24.71, 27.67)	0.11	REF
26–34 years	22.04 (20.27, 23.93)	25.46 (23.90, 27.09)	0.003	0.98 (0.91, 1.06)
35–49 years	14.25 (8.87, 15.77)	17.23 (16.10, 18.42)	<0.001	0.61 (0.55, 0.66)
50–64 years	10.38 (8.87, 12.11)	12.82 (11.42, 14.36)	0.015	0.39 (0.35, 0.44)
65+ years	4.79 (3.86, 5.92)	5.16 (4.18, 6.36)	0.63	0.15 (0.12, 0.18)
Gender				
Male	15.13 (13.89, 16.46)	17.31 (16.46, 18.20)	0.004	REF
Female	11.21 (10.53, 11.94)	13.00 (12.38, 13.64)	<0.001	0.69 (0.65, 0.74)
Race and ethnicity ^c				
Hispanic	10.42 (9.14, 11.85)	13.50 (12.14, 14.98)	0.009	0.59 (0.54, 0.65)
Non-Hispanic White	13.80 (12.78, 14.89)	15.88 (15.25, 16.53)	<0.001	REF
Non-Hispanic Black	15.00 (13.46, 16.68)	16.19 (14.76, 17.73)	0.22	0.84 (0.77, 0.92)
Non-Hispanic multiracial	21.72 (17.77, 26.27)	25.14 (20.97, 29.83)	0.24	1.43 (1.17, 1.74)
Another non-Hispanic race	8.34 (6.73, 10.30)	7.83 (6.12, 9.97)	0.84	0.44 (0.36, 0.54)
Educational attainment (ages 26+)				
Less than high school degree	10.44 (9.00, 12.08)	11.47 (9.87, 13.28)	0.53	REF
High school graduate/GED	11.95 (10.76, 13.24)	14.80 (13.47, 16.24)	<0.001	1.08 (0.97, 1.20)
Some college/Associate degree	15.80 (14.09, 17.67)	17.42 (15.79, 19.19)	0.14	1.36 (1.23, 1.51)
College graduate or more	9.94 (8.95, 11.03)	12.42 (11.54, 13.36)	<0.001	0.99 (0.88, 1.11)
Total annual family income				
Less than \$20,000	16.15 (14.59, 17.85)	18.91 (17.40, 20.50)	0.026	REF
\$20,000 to \$49,999	15.36 (14.09, 16.73)	15.81 (14.77, 16.90)	0.24	0.92 (0.84, 1.00)
\$50,000 to \$74,999	12.89 (11.44, 14.49)	15.65 (14.20, 17.21)	0.013	0.78 (0.70, 0.86)
\$75,000 or more	10.37 (9.59, 11.20)	13.20 (12.32, 14.13)	<0.001	0.62 (0.57, 0.68)

Bolded cells indicate statistical significance at $p < 0.05$.^a Adjusted linear test in trend of the effect of survey year on current cannabis use overall and by each sociodemographic subgroup^b Adjusted odds ratios and 95 % confidence intervals calculated using multivariable logistic regression between survey year and each sociodemographic characteristic and current cannabis use^c Another non-Hispanic race included respondents who identified as non-Hispanic Asian, non-Hispanic American Indian/Alaskan Native, and non-Hispanic Native Hawaiian/other Pacific Islander.

Role of Funding Source

Nothing declared.

CRedit authorship contribution statement

Delvon T. Mattingly: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization.
Maggie K. Richardson: Writing – review & editing, Formal analysis, Conceptualization.
Joy L. Hart: Writing – review & editing, Supervision, Conceptualization.

Declaration of Competing Interest

No conflict declared.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.dadr.2024.100253](https://doi.org/10.1016/j.dadr.2024.100253).

References

- Anderson, D.M., Fe, H.T., Liang, Y., Sabia, J.J., 2024. Recreational marijuana laws and teen marijuana use, 1993–2021. *JAMA Psychiatry* (e240698). DOI: 10.1001/jamapsychiatry.2024.0698.
- Center for Behavioral Health Statistics and Quality. (2014). 2013 National Survey on Drug Use and Health: Methodological Resource Book (Section 8, Data Collection Final Report). Substance Abuse and Mental Health Services Administration, Rockville, MD. Retrieved from <https://www.samhsa.gov/data/sites/default/files/NSDUHmrBDCFR2013.pdf>
- Center for Behavioral Health Statistics and Quality. (2015). 2014 National Survey on Drug Use and Health: Methodological Resource Book (Section 8, Data Collection Final Report). Substance Abuse and Mental Health Services Administration, Rockville, MD. Retrieved from <https://www.samhsa.gov/data/sites/default/files/NSDUHmrBDCFR2014.pdf>
- Center for Behavioral Health Statistics and Quality. (2016). 2015 National Survey on Drug Use and Health: Methodological Resource Book (Section 8, Data Collection Final Report). Substance Abuse and Mental Health Services Administration, Rockville, MD. Retrieved from <https://www.samhsa.gov/data/sites/default/files/NSDUHmrBDCFR2015.pdf>
- Center for Behavioral Health Statistics and Quality. (2017a). 2016 National Survey on Drug Use and Health: Methodological Resource Book (Section 8, Data Collection Final Report). Substance Abuse and Mental Health Services Administration, Rockville, MD. Retrieved from <https://www.samhsa.gov/data/sites/default/files/NSDUHmrBDCFR2016.pdf>
- Center for Behavioral Health Statistics and Quality. (2017b). Evaluation of imputation methods for the National Survey on Drug Use and Health (NSDUH). Substance Abuse and Mental Health Services Administration, Rockville, MD. Retrieved from <https://www.samhsa.gov/data/sites/default/files/NSDUH-PMNImputationMethods2015.pdf>
- Center for Behavioral Health Statistics and Quality. (2018). 2017 National Survey on Drug Use and Health: Methodological Resource Book (Section 8, Data Collection Final Report). Substance Abuse and Mental Health Services Administration, Rockville, MD. Retrieved from <https://www.samhsa.gov/data/sites/default/files/cbhsq-reports/NSDUHmrBDCFR2017.pdf>
- Center for Behavioral Health Statistics and Quality. (2019). 2018 National Survey on Drug Use and Health: Methodological Resource Book, Section 8: Data Collection Final Report. Rockville, MD: Substance Abuse and Mental Health Services Administration. Retrieved from <https://www.samhsa.gov/data/sites/default/files/reports/rpt23253/NSDUHmrBDCFR2018.pdf>
- Center for Behavioral Health Statistics and Quality. (2020). 2019 National Survey on Drug Use and Health (NSDUH): Methodological Resource Book, Section 8, Data collection final report. Rockville, MD: Substance Abuse and Mental Health Services Administration. Retrieved from (<https://www.samhsa.gov/data/sites/default/files/reports/rpt34659/NSDUHmrBDCFR2019.pdf>)
- Center for Behavioral Health Statistics and Quality. (2022). 2020 National Survey on Drug Use and Health (NSDUH) methodological resource book, Section 8: Data collection final report. Substance Abuse and Mental Health Services Administration. Retrieved from (<https://www.samhsa.gov/data/sites/default/files/reports/rpt38664/2020NSDUHmrBDCFR072522.pdf>)
- Center for Behavioral Health Statistics and Quality. (2023a). 2021 National Survey on Drug Use and Health (NSDUH) methodological resource book, Section 8: Data collection final report. Substance Abuse and Mental Health Services Administration.

- Retrieved from (<https://www.samhsa.gov/data/sites/default/files/reports/rpt41912/2021NSDUHmrbdCFR.pdf>)
- Center for Behavioral Health Statistics and Quality. (2023b). 2022 National Survey on Drug Use and Health (NSDUH) methodological resource book, Section 8: Data collection final report. Substance Abuse and Mental Health Services Administration. Retrieved from (<https://www.samhsa.gov/data/sites/default/files/reports/rpt44477/2022-nsduh-mrb-dcfr.pdf>)
- Compton, W.M., Han, B., Jones, C.M., Blanco, C., Hughes, A., 2016. Marijuana use and use disorders in adults in the USA, 2002-14: analysis of annual cross-sectional surveys. *Lancet Psychiatry* 3 (10), 954–964. [https://doi.org/10.1016/S2215-0366\(16\)30208-5](https://doi.org/10.1016/S2215-0366(16)30208-5).
- Connor, J.P., Stjepanovic, D., Le Foll, B., Hoch, E., Budney, A.J., Hall, W.D., 2021. Cannabis use and cannabis use disorder. *Nat. Rev. Dis. Prim.* 7 (1), 16. <https://doi.org/10.1038/s41572-021-00247-4>.
- Farokhnia, M., Harris, J.C., Speed, S.N., Leggio, L., Johnson, R.M., 2024. Lifetime use of alcohol and cannabis among U.S. adolescents across age: exploring differential patterns by sex and race/ethnicity using the 2019 NSDUH Data. *Drug Alcohol Depend. Rep.* 10, 100214 <https://doi.org/10.1016/j.dadr.2023.100214>.
- Farrelly, K.N., Wardell, J.D., Marsden, E., Scarfe, M.L., Najdzionek, P., Turna, J., MacKillop, J., 2023. The impact of recreational cannabis legalization on cannabis use and associated outcomes: a systematic review. *Subst. Abus.* 17, 11782218231172054 <https://doi.org/10.1177/11782218231172054>.
- Gali, K., Winter, S.J., Ahuja, N.J., Frank, E., Prochaska, J.J., 2021. Changes in cannabis use, exposure, and health perceptions following legalization of adult recreational cannabis use in California: a prospective observational study. *Subst. Abus. Treat. Prev. Policy* 16 (1), 16. <https://doi.org/10.1186/s13011-021-00352-3>.
- Hasin, D.S., 2018. US epidemiology of cannabis use and associated problems. *Neuropsychopharmacology* 43 (1), 195–212. <https://doi.org/10.1038/npp.2017.198>.
- Hasin, D., Walsh, C., 2020. Cannabis use, cannabis use disorder, and comorbid psychiatric illness: a narrative review. *J. Clin. Med* 10 (1). <https://doi.org/10.3390/jcm10010015>.
- Hasin, D., Walsh, C., 2021. Trends over time in adult cannabis use: a review of recent findings. *Curr. Opin. Psychol.* 38, 80–85. <https://doi.org/10.1016/j.copsyc.2021.03.005>.
- Jeffers, A.M., Glantz, S., Byers, A., Keyhani, S., 2021. Sociodemographic characteristics associated with and prevalence and frequency of cannabis use among adults in the US. *JAMA Netw. Open* 4 (11). <https://doi.org/10.1001/jamanetworkopen.2021.36571>.
- Keyes, K.M., Kaur, N., Kreski, N.T., Chen, Q., Martins, S.S., Hasin, D., Olfson, M., Mauro, P.M., 2022. Temporal trends in alcohol, cannabis, and simultaneous use among 12th-grade U.S. adolescents from 2000 to 2020: differences by sex, parental education, and race and ethnicity. *Alcohol Clin. Exp.* 46 (9), 1677–1686. <https://doi.org/10.1111/acer.14914>.
- Lapham, G.T., Matson, T.E., Bobb, J.F., Luce, C., Oliver, M.M., Hamilton, L.K., Bradley, K.A., 2023. Prevalence of cannabis use disorder and reasons for use among adults in a US state where recreational cannabis use is legal. *JAMA Netw. Open* 6 (8), e2328934. <https://doi.org/10.1001/jamanetworkopen.2023.28934>.
- Leinen, Z.J., Mohan, R., Premadasa, L.S., Acharya, A., Mohan, M., Byrareddy, S.N., 2023. Therapeutic potential of cannabis: a comprehensive review of current and future applications. *Biomedicines* 11 (10). <https://doi.org/10.3390/biomedicines11102630>.
- Mattingly, D.T., Patel, A., Hirschtick, J.L., Fleischer, N.L., 2022. Sociodemographic differences in patterns of nicotine and cannabis vaping among us adults. *Prev. Med Rep.* 26, 101715 <https://doi.org/10.1016/j.pmedr.2022.101715>.
- Melchior, M., Bolze, C., Fombonne, E., Surkan, P.J., Pryor, L., Jauffret-Roustide, M., 2017. Early cannabis initiation and educational attainment: is the association causal? data from the French TEMPO study. *Int. J. Epidemiol.* 46 (5), 1641–1650. <https://doi.org/10.1093/ije/dyx065>.
- Mody, L., Inouye, S.K., 2024. Adverse consequences of legalization of edible cannabis in older adults. *JAMA Intern Med.* <https://doi.org/10.1001/jamainternmed.2024.1337>.
- 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 Press. DOI: 10.17226/24625.
- Pagano, C., Navarra, G., Coppola, L., Avilia, G., Bifulco, M., Laezza, C., 2022. Cannabinoids: therapeutic use in clinical practice. *Int. J. Mol. Sci.* 23 (6) <https://doi.org/10.3390/ijms23063344>.
- Palamar, J.J., Le, A., Han, B.H., 2021. Quarterly trends in past-month cannabis use in the United States, 2015–2019. *Drug Alcohol Depend.* 219, 108494 <https://doi.org/10.1016/j.drugalcdep.2020.108494>.
- Rabiee, R., Lundin, A., Agardh, E., Forsell, Y., Allebeck, P., Danielsson, A.K., 2020. Cannabis use, subsequent other illicit drug use and drug use disorders: a 16-year follow-up study among Swedish adults. *Addict. Behav.* 106, 106390 <https://doi.org/10.1016/j.addbeh.2020.106390>.
- Shao, H., Du, H., Gan, Q., Ye, D., Chen, Z., Zhu, Y., Zhu, S., Qu, L., Lu, J., Li, Y., Duan, J., Gu, Y., Chen, M., 2023. Trends of the global burden of disease attributable to cannabis use disorder in 204 countries and territories, 1990–2019: Results from the Disease Burden Study 2019. *Int. J. Ment. Health Addict.* <https://doi.org/10.1007/s11469-022-00999-4>.
- Smart, R., Pacula, R.L., 2019. Early evidence of the impact of cannabis legalization on cannabis use, cannabis use disorder, and the use of other substances: findings from state policy evaluations. *Am. J. Drug Alcohol Abus.* 45 (6), 644–663. <https://doi.org/10.1080/00952990.2019.1669626>.
- Substance abuse and mental health services administration, 2023. Key substance use and mental health indicators in the United States: Results from the 2022 National Survey on Drug Use and Health (HHS Publication No. PEP23-07-01-006, NSDUH Series H-58). Center for Behavioral Health Statistics and Quality, Substance Abuse and Mental Health Services Administration, Rockville, MD. Retrieved from (<https://www.samhsa.gov/data/report/2022-nsduh-annual-national-report>).
- Uleanya, C., Yu, K., 2023. Data collection in times of pandemic: A self-study and revisit of research practices during a crisis. *Sage Open* 13 (1), 21582440231160698. <https://doi.org/10.1177/21582440231160698>.
- Watson, C.V., Puvanesarajah, S., Trivers, K.F., 2021. Racial and ethnic differences in marijuana use in e-cigarettes among US Youth in 2017, 2018, and 2020. *JAMA Pediatr.* 175 (7), 746–748. <https://doi.org/10.1001/jamapediatrics.2021.0305>.