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REVIEW

Is legalization of recreational cannabis associated with levels of use and cannabis use disorder among youth in the United States? A rapid systematic review

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Abstract
Cannabis legalization policies are rapidly changing in the United States. While there are concerns that recreational legalization will negatively affect young people, previous reviews have not provided clear indication of such effects. The purpose of this rapid systematic review was to examine whether recreational legalization was associated with increases in prevalence of cannabis use and use disorder among adolescents and young adults. PubMed/MEDLINE, Embase, Scopus, PsycInfo, Web of Science, Dissertations & Theses Global, the Trip Database, and OpenGrey were searched from date of inception through Marcy 17, 2022 to retrieve all relevant records. English language and human subject filters were applied. Two reviewers screened abstracts and titles, assessed full text articles, and coded the final included articles. Studies including primarily 10- to 19–year-olds were classified as adolescent, and those between 18 and 26 years as young adult. Our search identified 33 research reports (22 with adolescent samples; 14 young adult). For adolescents, ten studies reported no change in use prevalence associated with legalization, six reported a decrease, and seven reported an increase. Among young adults, most studies (8) showed an increase in at least one prevalence measure, four showed no change, and one showed a decrease. Only two adolescent and one young adult study examined cannabis use disorder, both adolescent studies showed an increase, and the young adult showed no change. The majority of studies had risk of bias. Recreational legalization may be associated with increases in prevalence of cannabis use in young adults while results for adolescents are mixed. Policymakers and practitioners should consider appropriate prevention and treatment options for young people.
Trial Registration: PROSPERO #CRD42021276984.

Keywords Cannabis use · Cannabis use disorder · Recreational cannabis legalization · Cannabis policy · Youth · Adolescent · Young adult

Introduction

Cannabis is one of the most frequently used substances among adolescents and young adults in the United States (US) and Europe [1]. Approximately 19% of individuals aged 15–24 in Europe and ~ 35% of individuals aged 18–25 in the US have used some form of cannabis in the past year [2, 3]. International approaches to cannabis legislation have been rapidly changing [4]. Several countries have legalized recreational use of cannabis for adults (e.g., Canada and Uruguay) and a number of other countries are considering such policy changes [5–8]. In the US, at the federal level, cannabis is classified as a Schedule I controlled substance (i.e., high potential for abuse and no acceptable medicinal use) [9]. However, liberalization of laws regulating cannabis and related legal consequences

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have evolved over the past 20 years with some states decriminalizing cannabis or allowing medicinal and/or recreational legalization for adults [10]. Recreational legalization, in particular, has recently gained broad traction in the US along with the concern that adolescents and young adults may be negatively impacted.

Concern for the negative impact of recreational legalization on adolescents and young adults stems from the idea that their access to and use of cannabis may increase, leading to cannabis use disorder (CUD) and/or other negative outcomes. For example, there may be adverse health outcomes and effects on cognitive, neural, and educational performance from frequent cannabis use among young people [11]. There is evidence that heavy cannabis use is associated with decreased subcortical volume and increased frontoparietal cortical thickness, disrupted functional development, and decreased executive functioning and IQ compared to non-using controls [12]. Current evidence also indicates that cannabis exposure in adolescents is associated with a number of negative behavioral health outcomes, such as increased prevalence and a worsened course of psychotic, mood, and addictive disorders, especially among adolescents with earlier age of onset, frequent and heavy use, and high-potency cannabis use [13]. Experts also cite the potential for acute effects, such as increased car crashes due to cannabis use while driving, and increased emergency department visits and hospitalizations from car crashes, psychiatric distress, and injuries [8, 14, 15].

Recreational legalization of cannabis started in the U.S. in 2012 with the following two Western states: Colorado and Washington. As of April 2022, 18 states, the District of Columbia and 2 territories (Guam and Northern Mariana Islands) have passed recreational legalization measures with 13 states having currently active retail sales (Fig. 1). Similar to Canada's experience with recreational legalization [8], there is a great deal of variability in how localities and state governments have regulated recreational cannabis and put protections in place for youth [16]. Variability is related to amount of cannabis individuals can possess and grow, public possession and use, marketing, licensing retail sales, and taxation [17, 18]. Regulations are frequently modeled after US alcohol policies, such as restricting sales to adults aged 21 and older [19]. Even within states, there is flexibility for counties and municipalities to further regulate local cannabis facilities with ordinances and zoning [20]. Despite regulations in place to protect adolescents, including prohibiting sales to them, there are a number of means that have been posited to impact adolescent use. For example, there are indications that adolescents may be unintentionally or intentionally gaining access or exposure to adult retail sales locations and/or marketing materials in states with recreational legalization [21]. Further, recreational legalization may decrease adolescents' perceptions of the risk or stigma related to cannabis use, increase their ability to purchase via third-parties, or impact illicit market availability and price [22–24].

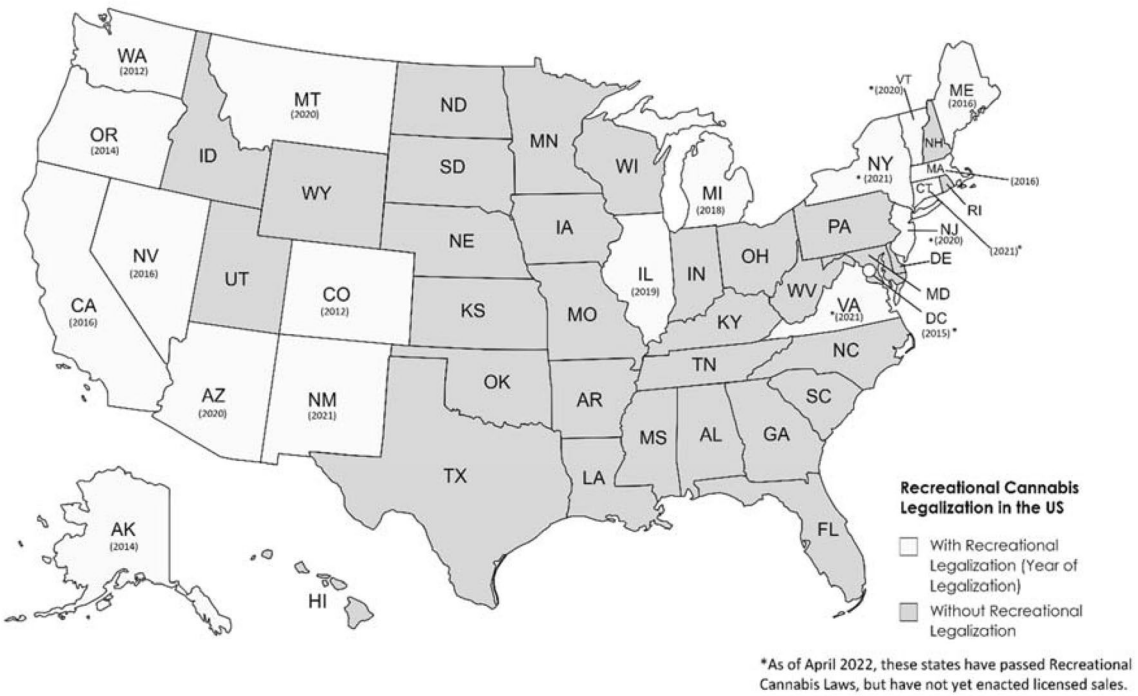

Fig. 1 Map of United States by state and recreational legalization status (year) of cannabis use

Previous systematic reviews do not provide a clear picture on the association of recreational legalization with the prevalence of cannabis use and CUD among adolescents and young adults in the US [13]. For example, a 2019 review of adolescents and young adults found a small increase in use of cannabis [25]. However, this review included only eight studies of recreational legalization, and these studies were from the three US states that were the earliest to pass recreational legalization. Further, only one study was rated as having a very low risk of bias, indicating potential design and quality issues with included studies. Another review concluded that an increase in cannabis use was associated with legalization, but only included three studies of adolescents or young adults from just one US state [26]. Other reviews have found mixed evidence or no association between legalization and changes in use for adolescents and young adults [7, 10, 27]. Results of previous reviews also indicate the that drawing strong causal conclusions about the impacts of recreational legalization may be difficult given that study designs often do not include control or comparison groups and that repeated cross-sectional studies conducted across several years may largely be estimating population-level associations rather than true causal effects [27].

Importantly, relatively little is known about how recreational cannabis legalization may be related to rates of CUD in young people. In fact, few reviews examined the association of liberalization of cannabis policy with CUD rates in adolescents and young adults [27]. For example, one study [10] suggested that a decrease in CUD rates among adolescents was associated with cannabis legalization, but this was based on two previous reviews, one of which only examined CUD rate trends over time rather than explicit associations with policy changes.

More systematic information is needed to fully understand whether recreational legalization is associated with outcomes in adolescents and young adults. An updated review is warranted given that the scientific literature on use and CUD may have expanded since the last reviews to include additional states and more studies on CUD. An additional 10 states have passed recreational legalization measures since the last review on adolescents and young adults was completed [28]. Therefore, the purpose of this review was to update what is known about the association of recreational legalization with adolescents and young adult cannabis use and disorder prevalence using a rapid review approach. Rapid reviews "assess what is already known about a policy or practice issue by using systematic review methods to search and critically appraise existing research" [29]. Rapid reviews aim to be rigorous while limiting the breadth or depth of the process to shorten the timescale of the study [29]; in the case of this study, we limited the scope by carefully focusing our research question and outcomes.

Our specific research question was as follows: Is an increase in cannabis use and CUD among adolescents and young adults associated with recreational legalization of cannabis? In this study, we consider adolescents and young adults as distinct populations for the following two reasons: 1) Previous studies on recreational cannabis legalization show different outcomes for adolescents (decrease in use) and young adults (increase in use) [14], and 2) they are in different developmental life stages with different goals and experiences [30, 31]. Studies including primarily 10 to 19-year-olds were classified as adolescent and those including primarily 18- to 26-year-olds as young adult [32, 33]. There is some overlap in these definitions among older adolescents and younger young adults in the 18- to 19-year range because of varying definitions of these terms and ages being somewhat arbitrary markers of the boundaries of both the developmental process and the social transitions that define young adulthood [32]. Therefore, we used social/developmental indicators to further classify studies (e.g., high school students as adolescents; college students as young adults). This review will add to the understanding of the public health implications of cannabis recreational legalization in the US and will provide important guidance for other countries considering implementing a similar policy.

Methods

Data source and search strategy

A rapid systematic review of studies testing quantitative differences in cannabis use and cannabis use disorder (CUD) among adolescents and young adults before and after recreational marijuana legalization policy change was conducted.

The protocol was registered in PROSPERO (#CRD42021276984) and we followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) reporting guideline [34]. The review's protocol guided all searching and screening methods (PROSPERO #CRD42021276984) [35]. Using sentinel articles to harvest and test search terms, we developed the following search strategy in PubMed/MEDLINE in order to retrieve all records using natural language and controlled vocabulary (when available) relating to the concepts of legalized cannabis and adolescents/young adults: ("Cannabis"[Mesh] OR cannabis[tw] OR marijuana[tw]) AND (legaliz*[tw] OR legalis*[tw]) AND (teen*[tw] OR youth*[tw] OR adolescen*[tw] OR juvenil*[tw] OR young*[tw] OR school*[tw] OR college*[tw] OR university[tw] OR "secondary education"[tw] OR "high education"[tw] OR "higher education"[tw] OR student*[tw] OR "Adolescent"[Mesh] OR "Young Adult"[Mesh]) NOT ("Animals"[Mesh] NOT ("Animals"[Mesh] AND "Humans"[Mesh])). This search

strategy used a previously published string to identify adolescent and young adult studies [36]. This PubMed/MEDLINE strategy was translated and adapted for the other databases.

The following databases were searched from date of inception through March 17, 2022: PubMed/MEDLINE (including Pre-MEDLINE and non-MEDLINE; 1945 to March 2022), Embase (OVID; 1974 to March 2022), Scopus (Elsevier; 1966 to March 2022), PsycInfo (Ebsco; 1872 to March 2022), Web of Science Core Collection (Editions: A&HCI, BKCI-SSH, BKCI-S, CCR-EXPANDED, ESCI, IC, CPCI-SSH, CPCI-S, SCI-EXPANDED, SSCI; Clarivate; 1895 to March 2022), Dissertations & Theses Global (ProQuest; 1861 to March 2022), the Trip Database (Trip Database Ltd, tripdatabase.com; through March 2022), and OpenGrey (opengrey.eu; through September 2021 as it is no longer active as of March 2022).

English language and human subject filters were applied when available. Additional records were found by searching the US government agencies (i.e., National Institute on Drug Abuse (NIDA) and Substance Abuse and Mental Health Services Administrative (SAMHSA)), and a think tank organization, RAND Corporation, websites dated on March 17, 2022. The cited references of reviews identified in the database searches were also screened, as were the cited and citing references of all included studies. These lists were compiled using citation indexes (Scopus, or Google Scholar when unavailable in Scopus), or manually using reference lists. ProQuest RefWorks (Legacy version) was used to deduplicate all records. The full search strategy, including detailed search terms, is further described in Appendix A. We identified articles in English only.

All titles and abstracts identified in the search were independently screened by two of the authors (MO and GR) to determine potential eligibility. To establish the final set of included studies, full texts of all potentially eligible studies were independently assessed by two of the authors (MO and GR) and they discussed further in case of disagreement. Inter-reviewer agreement was acceptable (Kappa = 0.57; 95% confidence intervals (CI) 0.37–0.77; $p \leq 0.001$).

Inclusion criteria

To be included, studies had to be conducted with individuals aged 26 or younger and quantitatively assess whether passage of recreational cannabis legalization policy in the United States was associated with changes in cannabis use and CUD prevalence. This age limit was selected as it is a meaningful cut-off for the potentially negative biological and psycho-social effects of cannabis as well as a frequently used upper bound to define young people [32]. We excluded studies: (a) exclusively based on participants aged 27 or older; (b) only reporting changes in attitudes, beliefs, and/or perceptions of cannabis use; (c) which did not make it possible to compare changes between before and after policy change (e.g., post-cannabis change only); (d) not including quantitative data (e.g., qualitative only); or (e) case studies, lectures, reviews, letters, opinions, and policy/commentary papers. Studies were excluded if they were: only conducted among adults over the age of 26, animal studies, conducted outside the US, focused only on medical legalization and/or decriminalization, or prior to recreational legalization of cannabis in the US (i.e., prior to 2012).

Risk of bias

In order to judge the quality of included studies, risk of bias was assessed using the Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies developed by the National Institutes of Health [37]. Two independent raters (MO and GR) evaluated each study. Studies defined as presenting a *very low* risk of bias had no identified flaws. Studies characterized by a *low* risk of bias provided insufficient information regarding the study time frame or loss to follow-up (where applicable). Studies considered to present a *possible* risk of bias were characterized by any of the following: (a) insufficient information about the study population recruitment or follow-up (where applicable); (b) insufficient definition of exposure or outcome; (c) a study period of < 1 year between exposure and outcome; or (d) insufficient adjustment for potentially confounding individual or contextual factors. Studies considered to present a *probable* risk of bias were characterized by two or more of the risks identified above. Coders discussed differences or discrepancies in ratings to come to a final rating.

Data extraction

A coding sheet was developed to identify the following: study authors/year, study location, study setting, publication type, dataset used, study period, inclusion criteria, study design, cannabis use and disorder measures, sampling approach, sample size, study population, statistical methods/covariates, key findings/outcomes and risk of bias. Two authors (MO and GR) independently extracted these data and any discrepancies were resolved through discussion.

Results

The PRISMA flow chart (Fig. 2) [34] shows how our search strategy resulted in the identification of 33 research reports (2 dissertations and 31 peer-reviewed articles) to be analyzed from 32 original studies. We report our results separately for adolescents and young adults. Studies including primarily 10- to 19-year olds (e.g., middle and high school students)

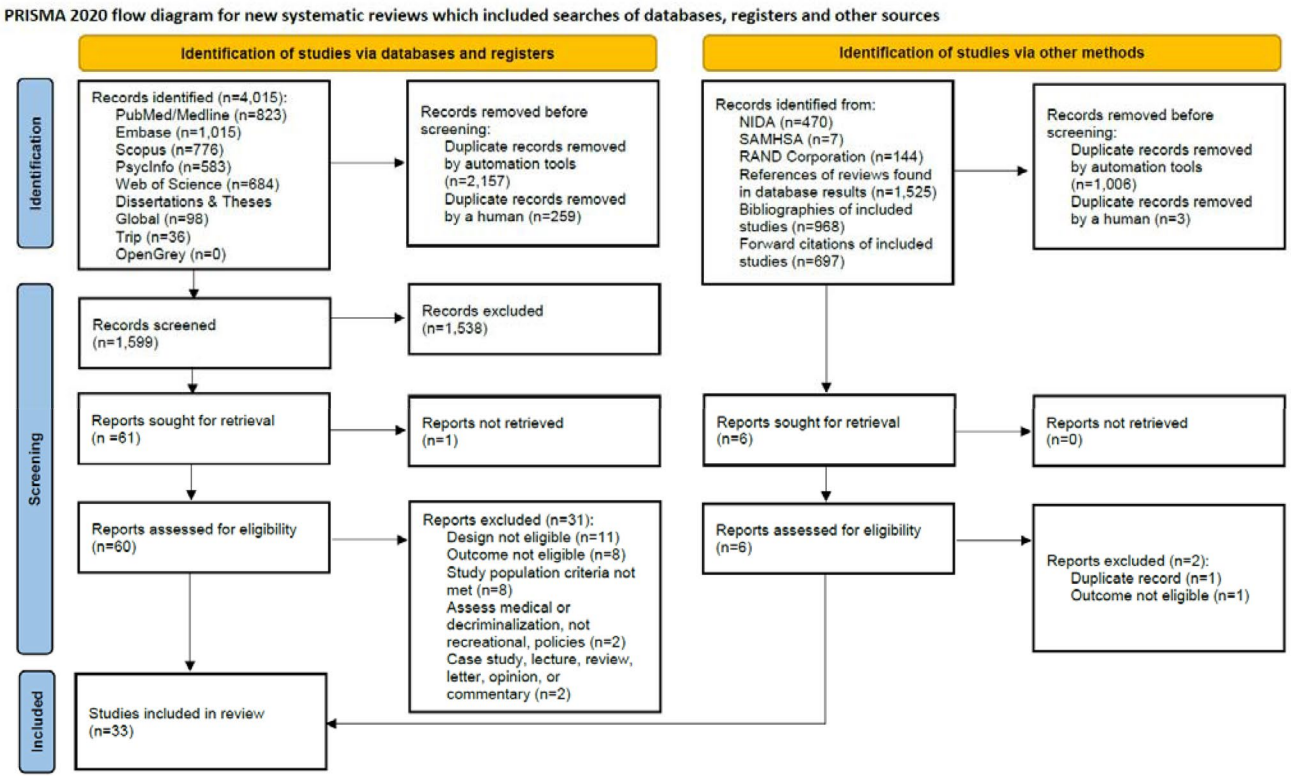

Fig. 2 Preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow diagram

were classified as adolescent and those including primarily 18- to 26-year olds (e.g., college students or other 18 + population) as young adult [28, 29]. If a study included both age groups, we reported separately for each in our results tables.

Prevalence of cannabis use and CUD in adolescents

Twenty-two research reports examined adolescent populations (Table 1). Most were conducted among samples from recreational legalization states in Washington (10; 45.5%), followed by Colorado (7; 31.8%), Oregon (4; 18.2%), California (3; 13.6%), Alaska (3; 13.6%) and 1 (4.5%) from each of the following: District of Columbia, Massachusetts, Maine, and Nevada. Three studies (13.6%) were conducted using national samples. Most studies used national (36.4%; e.g., Youth Risk Behavior Surveillance System (YRBSS)) or state (50.0%; e.g., Washington Healthy Youth Survey (HYS)) datasets, with fewer studies (22.7%) using data from randomized controlled trials (RCTs) or ongoing longitudinal studies. The most common research design was repeated cross-sectional (72.7%). Eight studies (36.4%) had a comparison group (e.g., non-recreational legalization states). Sample sizes varied greatly ranging from 170 to 3,330,912.

All adolescent studies examined some measure of use prevalence; most studies measured past 30-day use (72.7%). Other measures included were lifetime prevalence (e.g., ever use; 22.87%), past 60-day use (4.5%), past 90-day use (4.5%), and past-year use (4.5%). Only two (9.0%) studies examined CUD diagnosis or symptoms.

For the risk of bias assessment, three studies were characterized by a *very low* risk of bias, whereas 9.0% had *low*, 50.0% had *possible*, and 27.3% had *probable* risk of bias, respectively.

Results are quite mixed when examining the prevalence outcomes across studies. For example, ten studies (45.5%) reported no change in use prevalence associated with legalization, six studies (27.4%) reported a decrease in use prevalence, and seven studies (31.8%) reported an increase in use prevalence. However, the majority of studies (77.3%) had *probable* and *possible* risk of bias. When examining only the five studies (23.7%) with *low* or *very low* risk of bias, three studies (13.6%) reported no change in use prevalence associated with legalization, one study (4.5%) reported mixed results (one state with an increase and another state with no change), and one study (4.5%) reported an increase in use prevalence.

Two studies [38, 39] that examined CUD among adolescents found significant increases post-legalization; however, one of these had a *probable* risk of bias.

Table 1 Impact of recreational cannabis legalization on cannabis use and prevalence among adolescents in the United States

Study	Study period	Setting and data source	Study design; inclusion and exclusion	Sample size and participant characteristics	Cannabis use or disorder measure	Statistical methods/ covariates	Key findings	Risk of bias
Cerda et al. [38]	2008–2016	Colorado, Washington, Alaska, and Oregon; NSDUH National Survey	Repeated cross-sectional; excludes people who are homeless or living in institution Comparison: US states that did not enact recreational legalization	$N = 149,383$ 12 to 17-year-olds	Past-month use; past-year CUD (DSM-IV)	Multilevel logistic regression; Covariates: state proportions of males, individuals of white race/ethnicity, those aged 10 to 24 years, and those older than 25 years without a H.S. education. Individual-level covariates included respondent age, sex, race/ethnicity, nativity (US-born or non–US-born), urbanicity, and total family income	Prevalence of past-month use following legalization did not change; Past-year CUD prevalence increased slightly	Very low
Anderson et al. [55]	1993–2017	National; YRBSS	Repeated cross-sectional Comparison: US states that did not enact recreational legalization	$N = 1,610,605$ Middle and high school students; M age = 15.9 (1.23); 51.4% female	Past 30-day use	Multivariable logistic regression	Legalization was not associated with current use	Possible
Blevins et al. [39]	2012–2013	Washington; Randomized Trial	Pre-Post Cross-sectional; Must have used cannabis on at least 9 of past 30 days, remain in region through the study, not currently be in treatment, have no serious current psychiatric concerns Comparison: None	$N = 170$ high school students; M age = 16.03(.89); 34.1% female	Past 60-day use; CUD DSM-IV symptoms	ANOVA	Rates of use did not significantly vary pre-post legalization; Rates of cannabis-related problems and symptoms post legalization significantly higher	Probable

Table 1 (continued)

Study	Study period	Setting and data source	Study design; inclusion and exclusion	Sample size and participant characteristics	Cannabis use or disorder measure	Statistical methods/covariates	Key findings	Risk of bias
Coley et al. [56]	1999–2017	National: YRBSS	Quasi-experimental; Excluded younger than 14 and those missing demographic or substance use data Comparison: US states that did not enact recreational legalization	*N* = 1,142,479 high school students; 49.7% female; ages 14–18	Past 30 day use	Difference-in-difference; Adjusted for other marijuana policies (i.e., medical) and policies targeting alcohol and tobacco consumption, demographic characteristics, state unemployment rates, and state and year fixed effects	No evidence that legalization was associated with increased likelihood or level of use	Low
Dilley et al. [57]	2010–2016	Washington; Washington Healthy Youth Survey	Repeated cross-sectional Comparison: None	8th-12th graders; N Sample 1: Time 1, 47 561, Time 2, 26 133, Time 2: 53 220 N Sample 2: 2912 2597	Frequency (unspecified)	Unpaired, 2-tailed testing adjusted prevalence (%)	Cannabis use among youths declined after legalization among 8th and 10th graders	Possible
Estoup et al. [58]	2010–2015	Washington; Randomized Trial	Pre-post cross-sectional; Excluded if did not report substance use in 3 months prior to enrollment in school-based substance use intervention or school disenrollment Comparison: None	*N* = 262 high school students; 36% female; *M* age = 16	Past 3-month use	Mediation model	No significant increased use post-legalization	Possible
Lee et al. [59]	2009–2019	Alaska; YRBSS	Repeated cross-sectional Comparison: Hawaii (a non-recreational state)	*N* = 27,305 high school students; Hawaii: 50.05% female; Alaska: 48.28% female. Alaska mean age: 15.84 (1.22). Hawaii: 16.05 (1.25)	Lifetime and past 30-day Use	Difference-in-difference; Controlled for: age, gender, race	Legalization was associated with an increase in use	Possible

Table 1 (continued)

Study	Study period	Setting and data source	Study design; inclusion and exclusion	Sample size and participant characteristics	Cannabis use or disorder measure	Statistical methods/ covariates	Key findings	Risk of bias
Mason et al. [60]	2010–2013	Washington; Randomized Trial	Cohort comparison; students enrolled trial of Common Sense Parenting intervention Comparison: None	$N=238$ high school students; M age = 13.37 (.051); 48% female	Not specified	Multivariate multilevel regression; Controlled for substance use initiation at baseline and race	Legalization was not statistically associated with increase in cannabis use	Probable
Paschall et al. [61]	2010–2019	California; California Healthy Kids Survey	Repeated cross-sectional Comparison: None	$N=3,330,912$; 50.6% female	Lifetime and past 30-day Use	Multilevel regression; Controlled for demographics, secular trend, and urban/rural	Legalization was related to significantly greater likelihood of lifetime and past-30-day use	Possible
Pigeon [62]	2013–2017	Colorado; Healthy Kids Colorado Survey	Repeated cross-sectional Comparison: None	Time 1 N: 12,526; Time 2 N: 46,727 Time 1 Female: 49.1% Time 2 Female: 48.9%	Lifetime and past 30-day use	Chi-Square	Legalization was related to a decrease in lifetime use; no statistical difference in past 30-day use	Probable
Ta et al. [63]	2004–2016	Washington; Washington Healthy Youth Survey	Repeated Cross-Sectional; Inclusion: Kings county school districts Comparison: None	$N=14,055$ public school students	Past 30-day use	Percentage Estimates with 95% confidence intervals (weighted to the school district total enrollment by grade and sex)	Following legalization, past 30–day use decreased or remained stable through 2016 among students in grades 6, 8, 10, and 12	Possible
Cerda et al. [64]	2010–2015	Washington and Colorado; Monitoring the Future	Repeated cross-sectional Comparison: states that did not legalize recreational cannabis in this period	$N=253,902$; 8th, 10th, and 12th graders; 50.8% female, mean age = 15.6 (1.7)	Past 30-day use	Difference-in-difference	Significant increase in past-month use following legalization in eighth and tenth grades in Washington but not in Colorado	Very low
Paschall et al. [65]	2010–2019	California; California Healthy Kids Survey	Repeated cross-sectional; subgroup of past 30-day alcohol and marijuana co-users Comparison: None	$N=269,443$ 7th, 9th and 11th graders; 48.5% female	Past 30-day use	Multilevel regression; Controlled for: demographics, secular trend (school year), and urban/rural	Significant increase in the frequency of past 30 − day use following legalization	Possible

Table 1 (continued)

Study	Study period	Setting and data source	Study design; inclusion and exclusion	Sample size and participant characteristics	Cannabis use or disorder measure	Statistical methods/covariates	Key findings	Risk of bias
Paschall et al. [66]	2010–2018	Oregon; Oregon Student Wellness Survey	Repeated cross-sectional Comparison: counties that allowed recreational sales compared with counties that did not	$N=247{,}403$ 6th, 8th, and 11th graders; M age = 13.8; 50.7% female	Past 30-day use	Multilevel regression; Controlled for: demographics, secular trend (school year), and urban/rural	Prevalence of past 30 − day use increased, relative to the downward secular trend, after legalization	Possible
Rusby et al. [67]	2014–2016	Oregon; Longitudinal cohort study	Longitudinal quasi-experimental Comparison: None	$N=444$ middle school students; 53% female; average age @ Time 1 = 14.4	Past 30-day use	Zero-inflated poisson growth curve models. Youth gender and ethnicity were included as covariates	Legalization did not increase use for youth who did not use, but did increase use in youth who were already using	Probable
Harpin et al. [68]	2013–2014	Colorado; Healthy Kids Colorado Survey	Repeated cross-sectional Comparison: None	$N=24{,}171$ high school students; 50% female	Lifetime use and past 30-day use	Prevalence test using Chi-square	No significant changes in lifetime-use or past 30-day use	Probable
Brooks-Russel et al. [69]	2013–2015	Colorado; Health Kids Colorado Survey	Repeated cross-sectional Comparison: None	2013 ($N=26{,}019$); 2015 ($N=15{,}970$); 49% female	Lifetime use and past 30-day use	Prevalence test using Chi-square	No significant change in lifetime or past 30-day use	Low
Stone [70]	2008–2018	Washington; Washington Healthy Youth Survey	Repeated cross-sectional Comparison: none	$N=325{,}723$ 8th, 10th, and 12th graders; 50.8% female	Past 30-day use	Logistic regression	Proportion of past-30 day use remained relatively stable or trended downward slightly after legalization	Possible

Table 1 (continued)

Study	Study period	Setting and data source	Study design; inclusion and exclusion	Sample size and participant characteristics	Cannabis use or disorder measure	Statistical methods/ covariates	Key findings	Risk of bias
Anderson et al. [71]	1993–2017	National; YRBSS	Repeated cross-sectional Comparison: US states that did not enact recreational legalization	$N=1,414,826$	Past 30-day and frequent use	Multilevel Logistic Regression; adjusted for age, sex, grade in school, and race/ethnicity, whether marijuana use and possession were decriminalized in the respondent's state, the presence of a state-level 0.08 blood alcohol concentration law, the state beer tax, state income per capita, state unemployment rate, and indicators for 50 states and 12 years	Legalization was associated with a decrease in use and frequent use	Possible
Vigil et al. [72]	2006–2016	Colorado; state and national datasets (Healthy Kids Colorado, NSDUH, BRFSS)	Repeated Cross Sectional Comparison: None	Not reported	Not reported	Not reported	Past-30-day use among adolescents remained steady for more than ten years, pre- and post-legalization	Probable
Baily et al. [73]	2002–2018	Washington and Oregon; Seattle Social Development Project – The Intergenerational Project (SSDP-TIP)	Cohort Sequential (longitudinal); Analyses restricted to include youth who provided at least 1 data point between ages 10 and 20 and who lived in states with legalization at some point between 2015 and 2018 Comparison: None	$N=281$; 51% female	Past year use	Multilevel logistic regression; Controls: age, child sex, race, and birth cohort, as well as parent education	Youth were more likely to report past-year use after legalization	Very low

Table 1 (continued)

Study	Study period	Setting and data source	Study design; inclusion and exclusion	Sample size and participant characteristics	Cannabis use or disorder measure	Statistical methods/covariates	Key findings	Risk of bias
Weinberger et al. [74]	2004–2017	National (NSDUH): recreational legalization states included: AK, CA, CO, DC, MA, ME, NV, OR, WA	Repeated cross-sectional Comparison: US states that did not enact recreational legalization	Overall N=783,663 (examined age sub-groups of 12- to 17-year olds)	Any past 30 day use (yes vs. no)	Difference-in-difference (included fixed effects for calendar year and state of residence, and time-varying indicators for medical and recreational legalization). Adjusted for gender, race/ethnicity, age, income, education	Recreational legalization was associated with an overall increase in past-month cannabis for all age groups, but the 12–17 year old age group reported a decrease in cannabis-only use as well as cannabis-cigarette co-use	Possible

Prevalence of cannabis use and CUD in young adults

Fourteen research reports, from 13 different studies, examined young adult populations (Table 2). Most were conducted among recreational legalization state samples in Colorado (6; 46.2%) and Oregon (5; 38.5%), followed by Washington (4; 30.8%), California (3; 23.1%), Alaska (2; 15.4%) and one (7.7%) from each of the following: District of Columbia, Massachusetts, Maine, and Nevada. One study was conducted using a national sample (7.7%). Most studies used national datasets (8; 61.5%; e.g., National College Health Assessment (NCHA)). Others used data from ongoing survey or longitudinal studies (4; 30.8%) or a combination of state and national databases (1; 7.7%). The most common research design was repeated cross-sectional (8; 61.5%), followed by longitudinal (4; 30.8%), and pre-post cohort (1; 7.7%). About half of the studies included a comparison (7; 53.8%). Sample sizes varied widely, ranging from 338 to 834,274. Slightly more than half were conducted among college students (7; 53.8%).

All young adult studies examined some measure of use prevalence; most studies measured past 30-day use (69.2%). Other measures included were lifetime prevalence (e.g., ever use; 23.0%), past 28-day use (7.7%), past 14-day use (7.7%), and past 24-h use (15.4%). Only one study (7.7%) examined the prevalence of CUD.

For the risk of bias assessment, only one study was characterized by a *very low* risk of bias, whereas 15.4% had *low*, 61.5% had *possible*, and 23.0% had *probable* risk of bias, respectively.

When examining use prevalence outcomes among young adults, most studies (8; 61.5%) showed an increase in at least one prevalence measure, while four studies (30.8%) showed no change, and one showed a decrease (7.7%). However, the majority of studies (84.6%) had *possible* or *probable* risk of bias. When examining the only three studies (23.0%) with *low* or *very low* risk of bias, one study (7.7%) reported no change in use prevalence associated with legalization and two studies (15.4%) reported an increase in use prevalence.

Unlike the findings from the adolescent group, the only study that examined CUD found no significant change post-legalization [38].

Discussion

From a public health perspective, it is important to understand how recreational legalization of cannabis may be associated with prevalence of cannabis use and CUD among young people so that proper protections and policies can be developed and implemented. Because national data in the US have suggested that cannabis use has been increasing over the past decade among young adults and

Table 2 Impact of recreational cannabis legalization on cannabis use and prevalence among young adults in the United States

Study	Study period	Setting and data source	Study design; inclusion & exclusion	Sample size and participant characteristics	Cannabis use/disorder measure	Statistical methods/covariates	Key findings	Risk of bias
Parnes et al. [75]	2013–2015	Colorado; Survey	Pre-post cross-sectional; Introductory Psychology and Research Methods students Comparison: None	$N = 5421$; M age = 19.67 (2.43); 64.8% female	Lifetime and past 30-day use	Chi-Square; Negative binomial regression; Covariate: Age	Significant increase in the number of people having tried cannabis after legalization. Pre or Post Legalization status did not predict differences in past 30-day use	Probable
Parnes [76]	2013–2015	Colorado; Survey	Pre-post cross-sectional; Introductory Psychology and Research Methods students Comparison: None	$N = 5421$; M age = 19.67 (2.43); 64.8% female	Lifetime and past 30-day use	Chi-Square; ANOVA	Significant increase in the number of people having tried cannabis after legalization. Pre or Post Legalization status did not predict differences in past 30-day use	Probable
Bae et al. [48]	2008–2018	National; National College Health Assessment II	Repeated cross-sectional; Excluded data from one state because only 1 institution participated. Excluded 3144 participants because date of legalization coincided administration period Comparison: US states that did not enact recreational legalization	$N = 834{,}274$ college students; 67% female; 18–26 year olds	Past 30-day use	Multilevel Logistic Regression; Covariates: gender, sexual orientation, relationship status, residence type, race, ethnicity, legal drinking age, first year in school, international student, member of fraternity/sorority, enrollment size, private/public school, administration season	Positive association between legalization and past 30 day use	Low
Doran et al. [77]	2015–2019	California; Survey of non-daily cigarette smokers	Longitudinal; Included if smoked cigarette at least monthly for 6 months but never daily for 30 + days Comparison: None	$N = 563$; M age = 20.4 (1.8); 48% female	Past 14-day use; Daily (use in last 24 h)	Piecewise (segmented) multilevel longitudinal regression model; Controls: Time, sex, race/ethnicity, binary age	Frequency of use did not change significantly after legalization, and was stable throughout three years of observation	Possible

Table 2 (continued)

Study	Study period	Setting and data source	Study design; inclusion & exclusion	Sample size and participant characteristics	Cannabis use/disorder measure	Statistical methods/covariates	Key findings	Risk of bias
Kerr et al. [78]	2008–2016	Oregon; National College Assessment II	Repeated cross-sectional; selected data from two 4-year institutions that participated both prior to and after Oregon legalization went into effect. Further limited the sample to undergraduates ages 18–26 Comparison: 123 institutions in non-recreational states	*N* = 281,752 college students; 66.4% females in non-legalization schools; 60.1% in Oregon schools	Past 30-day use	Mixed-effects logistic regression; Controls: individual- (e.g., legal age, sexual orientation, gender, race, international student, first year student, residence type, fraternity/sorority, relationship status)	Following legalization, Oregon students (compared to non-legalization-state students) showed relative increases in rates of use	Possible
Kerr et al. [79]	2012–2016	Oregon; Healthy Minds Study	Repeated cross-sectional; one large university Comparison: 6 universities in states without recreational legalization	*N* = 10,924 college students; 55.3% female pre-legalization, 51.9% post-legalization	Past 30-day use	Mixed effects logistic regression; Controls: secular trends in use, individual vulnerability (e.g. depressive symptoms; other substance use), demographic (e.g. gender; race/ethnicity) and contextual (e.g. Greek system involvement; relationship status)	Rates of Oregon college students' use increased (relative to that of students in other states) following legislation, but only for those who reported recent heavy use of alcohol	Low

Table 2 (continued)

Study	Study period	Setting and data source	Study design; inclusion & exclusion	Sample size and participant characteristics	Cannabis use/disorder measure	Statistical methods/covariates	Key findings	Risk of bias
Wallace et al. [80]	2011–2015	Colorado; American College Health Association National College Health Assessment	Repeated cross-sectional; included college students attending one Colorado university who completed both the NCHA survey and additional Colorado university-specific questions Comparison: None	$N = 4052$; Female: time 1: 63.63%, 60.06%, 59.47%; M age Time 1: 22.41 (5.44), Time 2: 22.72 (5.57), time 3: 23.18 (5.20)	Lifetime use; Past 30-day use	Chi-square and Kruskal–Wallis test	Use initiation, and frequency in Colorado increased significantly across changes in legislation. Past 30-day use frequency increased significantly from pre-legalization to post-legalization, but did not significantly change from post-legalization to post-policy implementation	Possible
Miller et al. [81]	2005–2015	Washington; National College Health Assessment	Repeated cross-sectional; Included students at Washington State University Comparison: None	$N = 13,335$ college students; 48% female; M age = 20.49 (2.94)	Past 30-day use	Logit regression	Significant increase in use after legalization, larger than would be predicted by national trends	Possible
Cerda et al. [38]	2008–2016	Colorado, Washington, Alaska, and Oregon; NSDUH National Survey	Repeated cross-sectional; excludes people who are homeless or living in institution Comparison: US states that did not enact recreational legalization	$N = 153,947$ 18–25 year olds	Past-month use; past-year CUD according to DSM-IV	Multilevel logistic regression; Covariates: state proportions of males, individuals of white race/ethnicity, those aged 10 to 24 years, and those older than 25 years without a H.S. education. Individual-level covariates included respondent age, sex, race/ethnicity, nativity (US-born or non–US-born), urbanicity, and total family income	No associations between legalization and frequency of use and CUD were found	Very Low

Table 2 (continued)

Study	Study period	Setting and data source	Study design; inclusion & exclusion	Sample size and participant characteristics	Cannabis use/disorder measure	Statistical methods/covariates	Key findings	Risk of bias
Barker et al. [82]	2011–2016	Washington; Part of larger mixed methods study	Longitudinal; first-year college students at the two institutions. Eligibility criteria included age 17–19 years, English speaking, and pending full-time enrollment Comparison: Wisconsin (non-recreational state)	$N = 338$ college students; 56% female	Lifetime use and past 28 day use	Time series analyses were conducted using PraiseWinsten regression	Lifetime use did not change significantly more in Washington after legalization than in Wisconsin. Among prior users, the proportion using in the last 28 days rose faster in Washington after legalization than it did in Wisconsin	Possible
Kan et al. [83]	2015–2018	California; Ongoing longitudinal study (Crossroads Study)	Longitudinal; Eligible if they had been arrested only once for a moderate offense Comparison: Pennsylvania (non-recreational state)	$N = 982$; 0% female; *M* age: 19.04 (1.50)	Past 24-h use	Generalized Estimating Equations; Controls: age and race/ethnicity, self-reports of their parents' highest level of education, day of the week, time point	Participants in California did not demonstrate a significant increase in use after legalization or implementation Pennsylvania rates of use increased significantly	Possible
Stormshak et al. [84]	2000–2018	Oregon; 2 randomized trials	Longitudinal Cohort Comparison: None	$N = 1468$; *M* age at Wave 2: ~ 22; % female 48.2–49.4	Past 30-day use	Logistic Regression	Young adults after legalization are more likely to use than young adults were before legalization	Possible
Vigil et al. [72]	2006–2016	Colorado; state and national datasets (Healthy Kids Colorado, NSDUH, BRFSS)	Repeated Cross Sectional Comparison: None	Not reported	Not reported	Not reported	Use among 18–25-year-olds has gradually increased for over ten years, with no change in the trend around legalization	Probable

Table 2 (continued)

Study	Study period	Setting and data source	Study design; inclusion & exclusion	Sample size and participant characteristics	Cannabis use/disorder measure	Statistical methods/covariates	Key findings	Risk of bias
Weinberger et al. [74]	2004–2017	National (NSDUH): recreational legalization states included: AK, CA, CO, DC, MA, ME, NV, OR, WA	Repeated cross-sectional Comparison: US states that did not enact recreational legalization	Overall $N=783,663$ (examined age sub-groups of 18–25 year olds)	Any past 30-day use (yes vs. no)	Difference-in-difference (included fixed effects for calendar year and state of residence, and time-varying indicators for medical and recreational legalization). Adjusted for gender, race/ethnicity, age, income, education	Recreational legalization was associated with an overall increase in past-month cannabis for all age groups, but the 18–25 year old age group reported a decrease in cannabis-only use as well as cannabis-cigarette co-use	Possible

some sub-groups of adolescents (e.g., older, racial and ethnic minorities) [40], there has been concern among experts that recreational legalization may play a critical role in the increased use of cannabis beyond this time-based trend.

The results of this rapid review suggest a mixed picture for how recreational legalization is associated with cannabis use in adolescents. For example, while almost one-third of the reviewed studies found that there was an increase in prevalence of use related to recreational legalization, the majority found that the prevalence of use either decreased or remained unchanged. For young adults, the picture is a bit clearer in that over sixty percent of the reviewed studies found an increase in the prevalence of use. It is possible that the prevalence may have changed more readily than that of adolescents because young adults can legally access cannabis in retail stores once they turn the legal age to purchase (e.g., age of 21); however, additional research is needed to assess this. It is also possible that norms around use and reduced perceptions of perceived harmfulness are different among young adults and adolescents [7].

One of the most recent reviews and meta-analyses examining the association of recreational cannabis legalization among young adults and adolescents was conducted in 2018 and only included eight research reports [25]; the study found a small increase in cannabis use associated with legalization of recreational cannabis. Our rapid systematic review was able to expand to thirty-three studies given that more studies have been published in the past two to three years on this topic. This review also included states that were not represented in the previous review (i.e., Alaska, California, Massachusetts, Nevada, Maine). However, the previous review combined findings from adolescents and young adults; thus, this rapid review offers additional insight by showing different patterns of the use and CUD prevalence rates by age group after recreational legalization.

Several important points were noted based on the results of this review. First, very few studies examined CUD as an outcome of interest, and most focused on the prevalence of use. Among adolescents, only two studies examined CUD and both found evidence for increases associated with legalization; whereas among young adults, only one study examined the CUD, and found no change following legalization. However, more studies are needed to fully understand the impacts of legalization on CUD. The literature examining the effects of other types of cannabis laws (e.g., medical) on CUD is also similarly limited, with potential, but unclear, indication of CUD increases among youth [27]. Some studies have examined CUD treatment, which may provide some indication of changes in CUD prevalence, but many young people may not have access to treatment, may not perceive the need to seek treatment, or may have perceived stigma related to treatment [41, 42], so these studies only provide partial information at best. For example, one recent study

found that as cannabis use increased among young adults, treatment admissions declined in seven out of the eight states that legalized recreational cannabis during the study period [43]. This could indicate that more US young adults are using cannabis without developing CUD or that there is a growing unmet treatment need [43]. Similarly, a recent study among adolescents found CUD treatment admissions did not increase in Colorado and Washington after recreational legalization, and that treatment admissions declined during the study period in these states, as well as states without recreational legalization [44]. Careful monitoring is needed on both prevalence of CUD and treatment admissions in order to better understand access to care, treatment needs and outcomes.

Second, the majority of studies showed *possible* or *probable* risk of bias, and, therefore, the results of this review should be interpreted with caution. These biases were introduced by factors such as low survey response rates (< 50%), not including adjustment for proper control variables/covariates in statistical models, and/or insufficient time to assess impacts of legalization (e.g., less than one year). When examining studies only with *low or very low* risk of bias, the majority support no relationship between legalization and the prevalence of cannabis use prevalence in adolescents, but an increase among young adults; however, there are too few studies with *low* or *very low* risk of bias to draw compelling conclusions.

There are many challenges related to research designs when examining state-level policies, and these challenges were evident in the results of this review. Therefore, it may be difficult to draw firm causal conclusions about the impacts of recreational cannabis legalization. For example, only about one-third of adolescent studies and half of young adult studies included a comparison group. Further, simple before-and-after analyses may fail to capture secular trends in cannabis use and CUD after a policy change. Choo and Emery (2017) offer a set of analytic considerations for those interested in researching cannabis policy change [45]. For example, sufficient time points over a number of years pre and post legalization are needed to establish underlying trends and adjust for autocorrelation. Difference-in-differences analyses may offer a better option, but they are not without their criticisms as they often have a strong parallel trends assumption and can introduce bias due to regression to the mean [46]. Interrupted time series analyses with control groups may be the best option, but it may be difficult to identify the appropriate control group and sufficient data are needed [27]. Researchers should consider the strongest study designs possible so that more firm causal conclusions about cannabis policy changes can be drawn. Further, given the heterogeneity in legalization policy implementation in the US and base cannabis use prevalence rates by state, there is a need to account for such factors in study designs and interpretation of results [27, 47, 48]. Research designs may also need to consider threats to validity due to influential events other than cannabis law [45].

Third, we found clear differences in the results on adolescent populations as compared to young adult populations. This suggests that they should be treated as distinct populations in future studies and when considering policy recommendations and prevention and treatment services. Further, significantly more studies were identified for adolescent populations as compared to young adults in our review. In addition, those studying young adults were often among college students. More research is needed among young adults who are not college students.

In light of the results of this review, policy makers and practitioners have a number of considerations. For example, Fischer et al. (2017) offer evidence-based lower-risk cannabis use guidelines for use in medical and other settings [49]. The guide is meant to improve informed behavioral choices among cannabis users to improve public health outcomes. For example, one of the recommendations relates to high tetrahydrocannabinol (THC)-involved products, the main psychoactive compound in cannabis, because they are generally associated with higher risks of mental and behavioral problem outcomes. The guide suggests that cannabis users should know the nature and composition of the cannabis products, and ideally use cannabis products with low a THC level. SAMHSA also has prevention and treatment guides for adolescents [50] and young adults [51]. SAMHSA recommends practices such as cognitive restructuring, social norms campaigns, brief motivational enhancement interventions, screening and brief intervention, and holistic wraparound services (e.g., family-based interventions). SAMHSA also recommends environmental prevention strategies such as regulation of the price of cannabis, advertising and marketing, and retail store density.

This was a rapid review limited in scope. There are myriad important outcomes for young people besides use and CUD that were not examined in this review [7]. For example, recreational legalization may also impact mental and physical health (e.g., psychiatric symptoms), public safety (e.g., arrests, driving under the influence) and health service utilization (e.g., emergency department visits, CUD-related treatment admissions). According to research thus far, cannabis legalization does not appear to change youth arrest rates for cannabis possession, while adult arrest rates for possession have decreased after legalization [52]. However, cannabis possession arrests have increased over time for youth and adults in states that did not implement cannabis policy change [53]. Understanding how adolescent and young adult arrest rates, treatment admissions, CUD diagnoses, and policies and practices related to post-arrest mandated treatment interact may be an important area of investigation to provide further context to the impact of cannabis

legalization policies. We also only examined one cannabis policy change (i.e., recreational) rather than all types (e.g., medical purposes or decriminalization). Additionally, there may be important impacts on sub-groups that need to be understood in order to inform practice and policy, such as differences in how legalization affects use and disorder prevalence among different racial and ethnic groups, frequent users vs. non-users, or other factors (e.g., legal age, sexual orientation, and living arrangement) [45, 47, 54], especially with the goal of understanding health inequities and disparities that may result from legalization. Further, there may be some benefits (e.g., decreases in legal system involvement) from legalization to communities and individuals that need to be better understood from a public health perspective [25].

In conclusion, this rapid review suggests that young adults, as compared to adolescents, may be at particular risk for increases in use prevalence after implementation of recreational cannabis legalization. Further, we are not able to draw any comprehensive conclusions about how recreational legalization may be associated with the prevalence of CUD because this outcome was not considered in most studies. Recreational cannabis laws are still relatively new in the US. Eight states out of the 18 with recreational legalization policies have passed these policies since 2020; therefore, data are not yet available to examine outcomes in these states and some have not yet fully implemented retail sales. As this new set of states implement recreational legalization, surveillance data on cannabis use prevalence, CUD, health outcomes, public safety, treatment admissions, and healthcare utilization should be monitored closely. More time may be needed to fully understand recreational legalization policy impacts on young people. Updating reviews like this one periodically as well as conducting policy analysis and qualitative studies to understand variability in policy implementation and community experiences will be important as recreational legalization continues to expand in the US and other countries.

Appendix

A. Search strategy by database

Strategies for database searches (date of inception through March 17, 2022 except where noted).

Database	Search strategy	Hits
PubMed/Medline (including Pre-Medline and non-Medline)	("Cannabis"[Mesh] OR cannabis[tw] OR marijuana[tw]) AND (legaliz*[tw] OR legalis*[tw]) AND (teen*[tw] OR youth*[tw] OR adolescen*[tw] OR juvenil*[tw] OR young*[tw] OR school*[tw] OR college*[tw] OR university[tw] OR "secondary education"[tw] OR "high education"[tw] OR "higher education"[tw] OR student*[tw] OR "Adolescent"[Mesh] OR "Young Adult"[Mesh]) NOT ("Animals"[Mesh] NOT ("Animals"[Mesh] AND "Humans"[Mesh])) + English language filter	823
Embase (Ovid)	1. exp "cannabis use"/ or exp cannabis/ 2. (cannabis or marijuana).tw,kf or 2 4. (legaliz* or legalis*).tw,kf 5. exp adolescent/ 6. young adult/ 7. (teen* or youth* or adolescen* or juvenil* or young* or school* or college* or university or "secondary education" or "high education" or "higher education" or student*).tw,kf 8. 5 or 6 or 7 9. 3 and 4 and 8 10. Limit 9 to English language 11. 10 not ((exp animal/ or nonhuman/) not exp human/	1015
Scopus (Elsevier)	TITLE-ABS-KEY((cannabis OR marijuana) AND (legaliz* OR legalis*) AND (teen* OR youth* OR adolescen* OR juvenil* OR young* OR school* OR college* OR university OR "secondary education" OR "high education" OR "higher education" OR student*)) AND (LIMIT-TO(EXACTKEYWORD, "Human") OR LIMIT-TO (EXACTKEYWORD, "Humans")) AND (LIMIT-TO(LANGUAGE, "English"))	776

Database	Search strategy	Hits
PsycInfo (Ebsco)	(DE "Cannabis" OR TI cannabis OR AB cannabis OR KW cannabis OR DE "Marijuana" OR TI marijuana OR AB marijuana OR KW marijuana) AND (DE "Marijuana Legalization" OR TI legaliz* OR AB legaliz* OR KW legaliz* OR TI legalis* OR AB legalis* OR KW legalis*) AND (AG "Adolescence" OR AG "Young Adulthood" OR TI teen* OR AB teen* OR KW teen* OR TI youth* OR AB youth* OR KW youth* OR TI adolescen* OR AB adolescen* OR KW adolescen* OR TI juvenil* OR AB juvenil* OR KW juvenil* OR TI young* OR AB young* OR KW young* OR TI school* OR AB school* OR KW school* OR TI college* OR AB college* OR KW college* OR TI university OR AB university OR KW university OR TI "secondary education" OR AB "secondary education" OR KW "secondary education" OR TI "high education" OR AB "high education" OR KW "high education" OR TI "higher education" OR AB "higher education" OR KW "higher education" OR TI student* OR AB student* OR KW student*) AND LA "English" AND PO "Human"	583
Web of Science Core Collection (Editions = A&HCI, BKCI-SSH, BKCI-S, CCR-EXPANDED, ESCI, IC, CPCI-SSH, CPCI-S, SCI-EXPANDED, SSCI; Clarivate)	1. TI = (cannabis OR marijuana) OR AB = (cannabis OR marijuana) OR AK = (cannabis OR marijuana) 2. TI = (legaliz* OR legalis*) OR AB = (legaliz* OR legalis*) OR AK = (legaliz* OR legalis*) 3. TI = (teen* OR youth* OR adolescen* OR juvenil* OR young* OR school* OR college* OR university OR "secondary education" OR "high education" OR "higher education" OR student*) OR AB = (teen* OR youth* OR adolescen* OR juvenil* OR young* OR school* OR college* OR university OR "secondary education" OR "high education" OR "higher education" OR student*) OR AK = (teen* OR youth* OR adolescen* OR juvenil* OR young* OR school* OR college* OR university OR "secondary education" OR "high education" OR "higher education" OR student*) 4. ((#1) AND #2) AND #3 5. ((#1) AND #2) AND #3 and English (Languages)	684

Database	Search strategy	Hits
Dissertations & Theses Global (ProQuest)	ab((cannabis OR marijuana) AND (legaliz* OR legalis*) AND (teen* OR youth* OR adolescen* OR juvenil* OR young* OR school* OR college* OR university OR "secondary education" OR "high education" OR "higher education" OR student*)) OR su((cannabis OR marijuana) AND (legaliz* OR legalis*) AND (teen* OR youth* OR adolescen* OR juvenil* OR young* OR school* OR college* OR university OR "secondary education" OR "high education" OR "higher education" OR student*)) OR ti((cannabis OR marijuana) AND (legaliz* OR legalis*) AND (teen* OR youth* OR adolescen* OR juvenil* OR young* OR school* OR college* OR university OR "secondary education" OR "high education" OR "higher education" OR student*)) OR diskw((cannabis OR marijuana) AND (legaliz* OR legalis*) AND (teen* OR youth* OR adolescen* OR juvenil* OR young* OR school* OR college* OR university OR "secondary education" OR "high education" OR "higher education" OR student*))	98
Trip Database (tripdatabase.com)	(cannabis OR marijuana) AND (legaliz* OR legalis*) AND (teen* OR youth* OR adolescen* OR juvenil* OR young* OR school* OR college* OR university OR "secondary education" OR "high education" OR "higher education" OR student*)	36
OpenGrey (opengrey.eu) (through Sep 16, 2021, no longer available)	(cannabis OR marijuana) AND (legaliz* OR legalis*) AND (teen* OR youth* OR adolescen* OR juvenil* OR young* OR school* OR college* OR university OR "secondary education" OR "high education" OR "higher education" OR student*)	0
National Institute on Drug Abuse (NIDA, drugabuse.gov)	Separate searches: marijuana + English filter; cannabis + English filter	470
Substance Abuse and Mental Health Services Administration (SAMHSA, samhsa.gov)	Separate searches: "legalized marijuana"; "marijuana legalization"; "legalized recreational"	7
RAND Corporation (rand.org)	"legalized marijuana" OR "marijuana legalization" OR "legalize marijuana"	144

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