Review

Cannabis use among adolescents and young adults during the COVID-19 pandemic: A systematic review

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HIGHLIGHTS

- Conflicting evidence on changes in cannabis use trends was found among adolescents and young adults during the pandemic.
- Mental health symptoms emerged as significant factors linked to changes in cannabis use during the pandemic.
- Prospective studies and surveillance on cannabis use are needed to understand the long-term health impacts.

ARTICLE INFO

ABSTRACT

Background: A systematic review of the literature was performed to summarize cannabis use among adolescents and young adults during the COVID-19 pandemic. Special focus was given to the prevalence of cannabis use during COVID-19, as well as factors that may explain changes in cannabis consumption patterns.
Methods: The protocol of this systematic review was registered. Articles from seven publication databases were searched in January 2022. The inclusion criteria for studies were as follows: 1) published in English; 2) study instruments needed to include items on COVID-19; 3) conducted after January 1st, 2020; 4) published in a peer-reviewed journal, dissertation, or thesis; 5) study population ≤25 years of age; 6) study designs were limited to observational analytical studies; 7) measured cannabis use. This review excluded other reviews, editorials, and conference abstracts that were not available as full text manuscripts. Independent review, risk of bias assessment, and data abstraction were performed by two authors.
Results: Fifteen articles from the United States (n=11) and Canada (n=4) were included in this review. The findings of this review showed that the prevalence of cannabis use during the pandemic among adolescents and young adults were mixed. Some mental health symptoms, including depression and anxiety, were identified as the most commonly reported reasons for increased cannabis use during the pandemic.
Conclusions: This review highlights the inconsistencies in the prevalence of cannabis use among adolescents and young adults during the pandemic. Therapeutic interventions for mental health and continued public health surveillance should be conducted to understand the long-term effects of cannabis use among adolescents and young adults.

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1. Introduction

Internationally, there has been a notable escalation in both cannabis use and cannabis use disorder over the past 20 years (Alcohol and Drug Use, 2018). This trend is particularly prominent among adolescents (e.g., 12–17 year olds) and young adults (e.g. 18–25 year olds) (Patrick et al., 2021; Substance Abuse and Mental Health Services Administration, 2021), which has raised public health concerns. The initiation of cannabis use in adolescence has been associated with neuropsychological impairment (Arseneault et al., 2002; Cyrus et al., 2021; Harvey et al., 2007; Meier et al., 2018), psychosis (Kiburi et al., 2021), cannabinoid hyperemesis syndrome (Desjardins et al., 2015), respiratory symptoms (Boyd et al., 2021), and has a negative impact on educational achievement (Arria et al., 2015; Arria et al., 2013; Bolin et al., 2017; Suerken et al., 2016). A nationally representative survey conducted in the United States (US) revealed that 35 % of the individuals ≥12 years of age reported using cannabis in the past year. Specifically, within this group, 34.5 % were young adults between the age of 18 and 25, which corresponds to approximately 11.6 million people (Substance Abuse and Mental Health Services Administration, 2021). Furthermore, the prevalence of annual cannabis use has seen a discernible rise, increasing from 38 % in 2015 to 44 % in 2020 among college students in the US (Schulenberg et al., 2021).

Cannabis regulations vary across the world, yet are changing. For example, Canada legalized recreational cannabis at the federal level for adults aged 18 years and older in 2018. As of April 24, 2023, 38 states in the US have passed legislation to use cannabis or cannabinoids to manage specific medical conditions, and 23 states, 2 US territories, and the District of Columbia have legalized cannabis for adult recreational use (National Conference of State Legislatures, 2023). These evolving regulations have the potential to impact society in various ways. They could increase access to the drug, change social norms, and affect risk perceptions (Budney and Borodovsky, 2017; Hall, 2020). These changes may have downstream effects, particularly on adolescents and young adults who already have high prevalence of cannabis use.

Several studies have investigated the impact of recreational or medical legalization on cannabis use, but the results have been mixed and difficult to interpret. For example, a study conducted in the US showed an increase in cannabis use among 8th and 10th graders (2.0 % and 4.1 %, respectively) when comparing the prevalence before (2010–2012) and after (2013–2015) recreational cannabis legalization in Washington State (Cerdá et al., 2017). However, a separate study found that cannabis use among 8th and 10th graders in the same state decreased after passage of recreational cannabis laws (Dilley et al., 2019). Additionally, changes in laws can impact use indirectly such as allowing cannabis products to be packed and labeled in ways that might appeal to adolescents and young adults. In some cases, these products may closely resemble commonly consumed foods among this age group (MacCoun and Mello, 2015). Not surprisingly, the medicalization and legalization of cannabis products have led to a perception among adolescents and young adults that these products are less harmful. One US study indicated a substantial reduction in perceptions of harm among adolescents, regardless of their state of residence (Miech et al., 2017). However, a study conducted specifically in Colorado showed an increase in the perceived ease of access to cannabis following one year of recreational cannabis legalization, even though there were no changes in perceptions of harm or cannabis use behaviors (Harpin et al., 2018).

Furthermore, the global impact of Coronavirus Disease 2019 (COVID-19) is significantly altering the fabric of societies worldwide and may be impacting mental health and substance use in populations. Policies and regulations to prevent the spread of COVID-19 (e.g., social distancing and stay-at-home orders) increased social isolation and negatively impacted mental health, leading to a potential increase in cannabis use among adolescents and young adults. Even before the COVID-19 pandemic, adolescents and young adults frequently reported using cannabis to self-medicate and cope with anxiety, depression,

isolation, and other psychiatric symptoms (Bonn-Miller et al., 2007; Brodbeck et al., 2007; Wilkinson et al., 2016). Recent studies suggest that these COVID-19-related restrictions on daily activities may be associated with a rising prevalence of depression (Ettman et al., 2020; McGinty et al., 2020), anxiety (Holingue et al., 2020), loneliness (Killgore et al., 2020; Liu et al., 2020), and alcohol use (Barbosa et al., 2021; Nordeck et al., 2022; Pollard et al., 2020). Additionally, research has confirmed that adolescents and young adults experienced heightened stress and anxiety as a result of the sudden societal changes implemented during the COVID-19 pandemic, such as university closures, decreased social connectedness, and greater anxieties regarding academic performance and job pressure (Son et al., 2020; Wang et al., 2020). Young adults aged 18–24 years were found to be particularly vulnerable during the pandemic, with mental health issues being the most common reasons for cannabis use (Czeisler et al., 2020); the COVID-19 pandemic has also been associated with increased cannabis use to cope with stress or emotions related to the pandemic among adolescents and young adults (Czeisler et al., 2020; Fedorova et al., 2021; Patrick et al., 2021).

Considering the importance of the pandemic and the high prevalence of cannabis use among adolescents and young adults, an overall review of research on cannabis use during the COVID-19 pandemic among this population has not yet been conducted. Additionally, studying the impact of COVID-19 pandemic on cannabis use patterns among adolescents and young adults offers valuable insights into understanding the potential impact of social isolation and equips us with improved readiness to address health consequences associated with future pandemics. Thus, the purpose of this systematic review was to comprehensively synthesize the recent literature about the prevalence of cannabis use during COVID-19, as well as factors contributing to cannabis use and related outcomes (e.g., depression, anxiety, isolation), among adolescents and young adults during the COVID-19 pandemic. Although the adverse effects and motives of cannabis use among this population have been described, the findings of this review aim to identify the specific reasons of cannabis use among adolescents and young adults and how cannabis use changed during the pandemic among this population.

2. Methodology

2.1. Data source and search strategy

This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines, which were used to guide the design, execution, and reporting of findings (Moher et al., 2015) (Appendix 1). The protocol for this systematic review was registered on PROSPERO (CRD42021290288). The following literature databases were searched for eligible studies: 1) PubMed; 2) CINAHL Complete (within EBSCO host); 3) PsycINFO; 4) Scopus; 5) Academic Search Complete (within EBSCO host); 6) Web of Science; and 7) ProQuest Databases. All searches were performed by YT with the assistance of TMR and ELW. Searches were performed in January 2022. Detailed keyword searches of each literature database are included in Appendix 2. The inclusion criteria for eligible studies in this review were as follows: 1) published in English as original research; 2) study instruments needed to include COVID-19 assessment (e.g., COVID-19 related mental health issues or cannabis use compared with pre-pandemic); 3) study conducted after January 1, 2020 (Centers for Disease Control and Prevention, 2021); 4) published in a peer-reviewed journal, dissertation, or thesis; 5) study participants ≤25 years of age that met the definition of young adults (Sawyer et al., 2018; Society for Adolescent Health and Medicine, 2017); 6) limited to observational analytical study designs (i.e., cross-sectional, case-control, cohort); and 7) measured cannabis use. Reviews and editorials of these types of studies were excluded. Conference abstracts that were not available as full text manuscripts were also excluded as the overall study could not be assessed for bias.

2.2. Study selection process

Prior to title/abstract and full-text screening, all reviewers were trained to ensure that they understood the review's goals and study inclusion criteria. EndNote™ software, version X9, was used to combine the abstracts and titles obtained from the different literature databases. Duplicates of studies that were found in multiple databases were removed. YT and FO, who had prior familiarity with systematic review methodology, independently screened titles and abstracts. These individuals met to compare their results and resolve any discrepancies. A third reviewer resolved any outstanding disagreements (TMR). EndNote™ was used to record the inclusion and exclusion decisions. Any papers that appeared to meet the inclusion criteria based on the initial title and abstract search were obtained as full-text articles. The full-text articles were then reviewed independently by YT and BK in their entirety to evaluate eligibility, with inclusion and exclusion decisions documented in EndNote™. These individuals met again to compare their results and resolve any discrepancies. Any disagreements regarding the inclusion of studies were resolved by discussion, and TMR acted as the arbitrator to make a final decision for inclusion.

2.3. Study quality assessment

The quality of eligible articles was assessed after completing the full-text review. This study used the Joanna Briggs Institute (JBI) Critical Appraisal Checklist (Moola et al., 2020), which is used to evaluate methodological quality and to identify the extent to which a study addressed the possibility of bias in its design, conduct, and analysis. This review used the cross-sectional and cohort study checklists because the review only included observational analytical study designs. The cross-sectional checklist contained a total of eight factors bifurcated by study design and the cohort study contained 11 factors, such as measurement of exposures, identification and handling of confounders, and appropriate statistical analyses (Moola et al., 2020) (*detailed JBI checklist instructions are provided in* Appendix 3 and 4). YT and BK independently evaluated the included studies for quality based on the JBI checklist instructions. The rating criteria were based on the explanation provided by the JBI to mark "Yes (Y)", "No (N)", and "Unclear (U)" on cross-sectional and cohort study checklists, and chose the overall appraisal as "include", "exclude", or "seek further info" for each study (Moola et al., 2020). After completing the quality assessments and documenting them in a Microsoft Excel spreadsheet, two authors met and compared their results for accuracy and/or precision to reach consensus. TMR acted as the arbitrator if a consensus was not reached.

2.4. Data synthesis and abstraction

Another data abstraction form was built in Microsoft Excel to facilitate the synthesis of the findings from the included studies. The form included year of publication, the country in which study was conducted, study design, sample size, sample type, topic themes, recruitment time period, statistical analysis, cannabis/cannabis measurement, other substance use, and main findings. Additionally, six main themes were identified across the studies included in this review: 1) prevalence and trends of cannabis use during the COVID-19 pandemic; 2) demographics; 3) mode of consumption; 4) factors contributing to use; 5) Substance use other than cannabis during the COVID-19 pandemic; and 6) Other important findings. The coding is given in Table 1. No meta-analysis was performed given the heterogeneity of study population and statistical analyses. YT and BK compared their accuracy and/or precision. Any disagreements were resolved through discussion and TMR acted as the arbitrator if a consensus was not reached.

Table 1
Coding of main themes identified in the review.

Themes	Coding	N (%)
Prevalence and trends of cannabis use during the COVID-19 pandemic	1	15 (100 %)
Demographics	2	14 (100 %)
Mode of consumption	3	3 (20 %)
Factors contributing to use	4	14 (93 %)
Substance use other than cannabis during the COVID-19 pandemic	5	13 (87 %)
Other important findings	6	4 (27 %)

3. Results

3.1. Study characteristics

Searches of the seven databases yielded 278 articles, and 15 studies were identified for inclusion in this review. A flow diagram documenting the search process and reasons for excluding studies is shown in Fig. 1. The characteristics of these studies are summarized in Table 2. Of these studies, 11 studies were conducted in the US (Bonar et al., 2021; Clendennen et al., 2021; Dyar et al., 2021; Graupensperger et al., 2021; Hicks et al., 2022; Miech et al., 2021; Nguyen et al., 2021; Papp and Kouros, 2021; Patrick et al., 2021; Sharma et al., 2020; Tucker et al., 2020) and four were conducted in Canada (Bartel et al., 2020; Dumas et al., 2020; Leatherdale et al., 2021; Potvin et al., 2022). Eight articles were cross-sectional studies (Bonar et al., 2021; Clendennen et al., 2021; Dumas et al., 2020; Graupensperger et al., 2021; Nguyen et al., 2021; Potvin et al., 2022; Sharma et al., 2020; Tucker et al., 2020) and the rest involved a longitudinal/cohort design (Bartel et al., 2020; Dyar et al., 2021; Hicks et al., 2022; Leatherdale et al., 2021; Miech et al., 2021; Papp and Kouros, 2021; Patrick et al., 2021). Sample sizes for the studies ranged from 70 to 17,052. Most of the included studies (N=12) used a non-random selection of participants, including convenience, purposive, or volunteer sampling (Bartel et al., 2020; Bonar et al., 2021; Dumas et al., 2020; Dyar et al., 2021; Hicks et al., 2022; Leatherdale et al., 2021; Nguyen et al., 2021; Papp and Kouros, 2021; Potvin et al., 2022; Sharma et al., 2020; Tucker et al., 2020). All (N=13) studies included in this review recruited participants online during the pandemic period due to the social distancing policies; some longitudinal studies conducted assessments in-person before the pandemic (Leatherdale et al., 2021; Miech et al., 2021; Papp and Kouros, 2021), and one study recruited participants as part of a clinical trial (Bonar et al., 2021). With respect to study quality (Tables 3 and 4), all cohort studies in this review had an "unclear" justification of the appropriate length of time for follow-up for the study outcome to occur; most cross-sectional studies in this review were "unclear" on the objective criteria for the included study population based on either a specified diagnosis or definition.

3.2. Prevalence of Cannabis use during the COVID-19

The reported prevalence of cannabis use varied greatly due to a significant degree of heterogeneity across the studies included in this review. The prevalence of cannabis use during the pandemic ranged from 6.5 % to 88.3 % as some studies utilized different prevalence time frames of cannabis use, such as the past 30 days (Bartel et al., 2020; Clendennen et al., 2021; Dyar et al., 2021; Graupensperger et al., 2021; Hicks et al., 2022; Leatherdale et al., 2021; Miech et al., 2021), the past 3 weeks (Dumas et al., 2020), or the past year (Leatherdale et al., 2021). Seven studies found that participants cannabis use remained stable or even reduced during the pandemic (Bonar et al., 2021; Clendennen et al., 2021; Dumas et al., 2020; Hicks et al., 2022; Leatherdale et al., 2021; Miech et al., 2021; Nguyen et al., 2021). One study found that the participants who reported increases frequency and quantity of cannabis was 67.0 % and 54.2 % (Dyar et al., 2021).
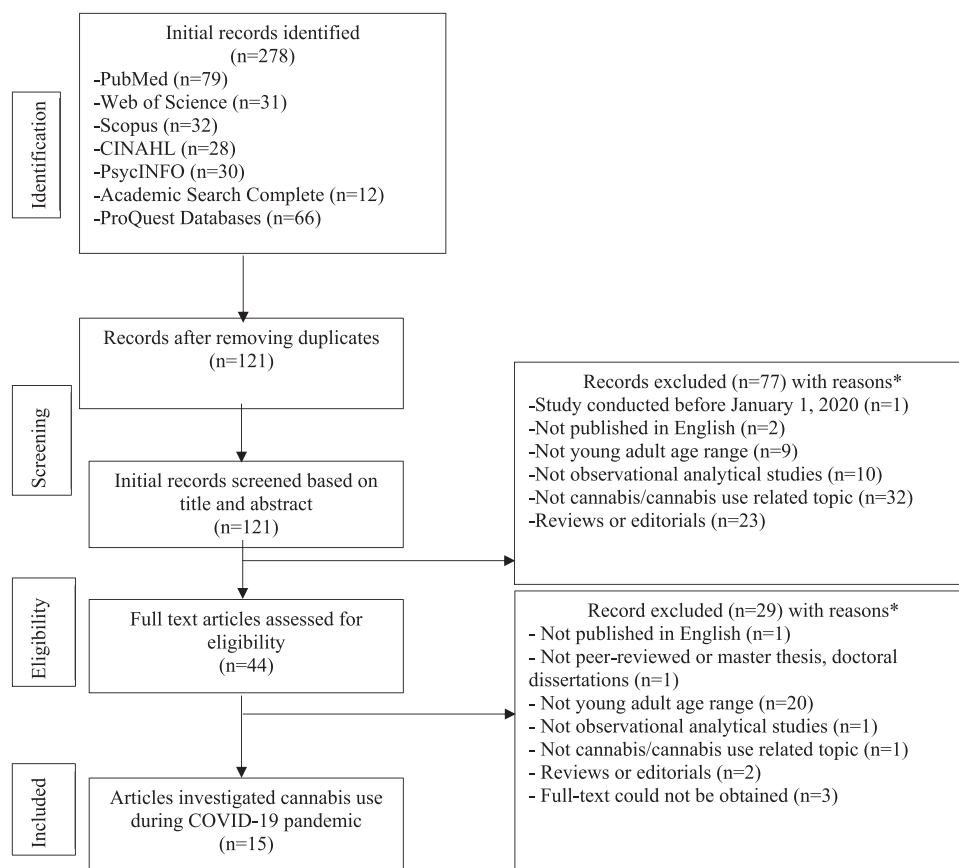
Fig. 1. PRISMA Flow chart of database search and selection of studies. Studies could have been excluded for multiple reasons.

The methodological differences, including the study design and data source, may prohibit direct comparison of the study results and may partially explain the conflicting results regarding changes in cannabis use during the pandemic. Five studies assessed baseline cannabis use several years prior to the pandemic compared to cannabis use from pre-pandemic to during the pandemic (Clendennen et al., 2021; Hicks et al., 2022; Leatherdale et al., 2021; Miech et al., 2021; Patrick et al., 2021), with the earliest baseline assessment conducted in 2014–2015 (Clendennen et al., 2021). Two studies, Miech et al. and Patrick et al., used the Monitoring the Future (MTF) data, but Patrick et al., used the data from the MTF Vaping Supplement (excluded random selection into the MTF longitudinal study or without contact information) (Patrick et al., 2021).

3.3. Demographics

It is important to highlight that the varied prevalence of cannabis use across the studies in this review may also be attributed to the heterogeneous demographic characteristics of the study participants despite the similar age range. All studies provided information about the demographic characteristics of the study population. Seven of the 15 included studies had a study population with an age range of 18–25 (Bartel et al., 2020; Bonar et al., 2021; Dyar et al., 2021; Graupensperger et al., 2021; Papp and Kouros, 2021; Sharma et al., 2020; Tucker et al., 2020), three studies included subjects less than 18 years old (Clendennen et al., 2021; Nguyen et al., 2021; Potvin et al., 2022), three studies included only subjects ≤18 years old (Dumas et al., 2020; Miech et al., 2021; Patrick et al., 2021). Four studies included only high school students (Dumas et al., 2020; Leatherdale et al., 2021; Miech et al., 2021; Patrick et al., 2021), and three studies included only college students (Graupensperger et al., 2021; Hicks et al., 2022; Papp and Kouros, 2021). One study was conducted in an outpatient setting (Sharma et al., 2020), and one study was conducted among participants who were

experiencing homelessness (Tucker et al., 2020). Thirteen studies in this review reported that more than half of the study participants were female, one study had 72 % male participants (Tucker et al., 2020), and one study only recruited female participants who were self-identified as sexual minorities (Dyar et al., 2021). Due to this reason, it is impossible to determine whether these gender differences in prevalence rates because the studies did not use proportionate sampling by gender. Six studies recruited study participants with previous substance use, as well as cannabis (Bartel et al., 2020; Bonar et al., 2021; Clendennen et al., 2021; Dyar et al., 2021; Papp and Kouros, 2021; Sharma et al., 2020; Tucker et al., 2020). One study noted that the prevalence of cannabis use decreased for females only (Dumas et al., 2020), and another study showed that females were more likely to maintain cannabis use when compared to males (Leatherdale et al., 2021).

Several studies noted that more participants reported increasing cannabis use during the pandemic among those who identified as current cannabis users (Clendennen et al., 2021), self-identified as sexual minorities (Hicks et al., 2022), had recent prescription drug misuse (Papp and Kouros, 2021), and those who reported ever-vaporizing cannabis (Nguyen et al., 2021). Although the majority of the participants in these studies were White, one study showed that 'other races' (which includes Asian, American Indian or Alaska Native, and Native Hawaiian or Other Pacific Islander) were more likely to report increased cannabis use during the pandemic (Clendennen et al., 2021).

3.4. Mode of consumption

Only three studies investigated the prevalence of cannabis via different modes of consumption, including smoking (Bartel et al., 2020; Bonar et al., 2021), vaping (Bartel et al., 2020; Bonar et al., 2021; Nguyen et al., 2021), dabbing (Bonar et al., 2021), and eating (Bonar et al., 2021; Nguyen et al., 2021). One study asked participants about

Table 2
Characteristics of Included studies of cannabis use during the COVID-19 pandemic.*

First author (Publication year)/ Country	Study design	Study population	Sample size/type	Topic theme**	Statistical analysis	Recruitment time	Cannabis measurement	Study purpose	Other substance use	Main findings of relevant
Bartel et al. (2020) / Canada	Longitudinal	Aged 19 and 25 years who had to have used alcohol >=4 times and used cannabis recreationally >=2 times in the past month at baseline	N=70 Convenience sampling (Study populations were enrolled in an ongoing Canadian longitudinal study on substance use)	1,2,3,4	Descriptive statistic and linear regression	March 23-June 5, 2020; Participant pre-pandemiccannabis use data were extracted from the previous timepoint in our longitudinal study, four months earlier.	Cannabis Use Questionnaire: 3 items from the Daily Sessions, Frequency, Age of Onset, and Quantity of Cannabis Use Inventory to assess cannabis use frequency, quantity in typical a single sitting, and primary method of useBCAMM: 6-item version of the Cannabis Motives Measure	To assess the association between isolation and loneliness and increased cannabis use, as well as using cannabis to cope with negative affect due to COVID-19	Not reported	Self-isolation and coping with depression motives for cannabis use during the pandemic were significant predictors of pandemic cannabis use, but no interaction between coping with depression motives and self-isolation on cannabis use during the pandemic.
Bonar et al. (2021) / Michigan, US	Cross-sectional	Aged 18–25 years old and had past-month cannabis use with THC 3+ times per week within an ongoing online pilot RCT of cannabis intervention	N=141 Voluntary response (recruited using social media ads)	1,2,3,4,5,6	Descriptive statistics (chi-square analysis)	February (Wave 1)-May 2020 (Wave 2) COVID-19 aspects: May-June,2020	Timeline Follow Back: past 30 days cannabis use daysPast 30 days cannabis use methods, medical cannabis certification, sources of cannabis acquisition, hours high per day, and time to first use upon waking were adapted from prior work	To examine self-reported perceptions of changes in cannabis and alcohol use and other psychosocial outcomes before/ during the pandemic	Alcohol, tobacco, and vaping nicotine	A third to a half-increased cannabis use with 20–30 % reporting decreases across methods. People who reported cannabis smoking and eating increased were significantly more likely to report increases in depression, anxiety, and stress.
Clendennen et al. (2021) / Texas, US	Cross-sectional	Aged 16–24 years old from the TATAMS and report any past 30-day use of cannabis, e-cigarettes, and cigarettes	N=709 Complex cluster-based sampling	1,2,4,5	Descriptive statistics and multivariable logistic regression models (AOR)	2014–2015 (Baseline/ Wave 1)Spring 2020 (COVID-19 assessment)	Past 30-days cannabis behaviors attributed to COVID-19	To examine the prevalence of self-reported COVID-19 related changes in the past 30 days cannabis, e-cigarette, and cigarette use behaviors	E-cigarette and cigarette use	Cannabis, e-cigarettes, and cigarettes use were sustained or increased due to COVID-19. Participants who reported dependence symptoms were significantly more likely to report increasing cannabis use than non-dependent peers. Youth and young adults who reported "other" race/ ethnicity, compared to non-Hispanic

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Table 2 (*continued*)

First author (Publication year)/ Country	Study design	Study population	Sample size/type	Topic theme**	Statistical analysis	Recruitment time	Cannabis measurement	Study purpose	Other substance use	Main findings of relevant
										white, were significantly more likely to report using cannabis more due to the COVID-19 pandemic.
Dumas et al. (2020) / Canada	Cross-sectional	Aged 16–18 years old of high school students and 14–18 years of age of adolescents	N=1054 Voluntary response (an advertisement was posted on research laboratory's Instagram pages for a week)	1,2,5,6	Descriptive statistics and binary logistic regressions (UOR)	April 4th-13th, 2020	Number of days of cannabis use in the past 3 weeks before the COVID-19 crisis and since the COVID-19 crisis (e. g., the past 3 weeks)	To explain how adolescents' substance use has changed during the COVID-19 pandemic and to examine developmentally salient predictors of adolescents' substance use patterns during social distancing	Alcohol and vaping products	The percentage of cannabis use decreased for girls only, and the frequency of cannabis use for average number of cannabis using days increased significantly from pre-covid to post-covid and this increase only significant for girls not for boys.
Dyar et al. (2021) / US	Longitudinal	Aged 18–25 years old identified as lesbian, bisexual, pansexual, or queer, were assigned female at birth and reported having 4 or more drinks on a single occasion at least twice and/or using cannabis on at least 3 days in the past month	N=212 Voluntary response	1,2,4,5,6	Maximum likelihood estimation	August 2020-February 2021	Retrospective changes in cannabis use quantity and frequency; retrospective changes cannabis use contexts; coping motives for cannabis use; cannabis use consequences;	To examine associations between hypothesized risk factors and retrospectively reported changes in alcohol and cannabis consumption, associations between hypothesized risk factors and recent coping motives and substance use consequences; and prospective associations between these risk factors and subsequent changes in coping motives, consequences, and substance use quantity and frequency over a 1-month period	Alcohol	Retrospectively reported increases in anxiety and depression since before the pandemic were associated with retrospectively reported increases in alcohol and cannabis use quantity and frequency. However, COVID anxiety was only significantly associated with increases in drinking (but not cannabis) quantity and frequency.
Graupensperger et al. (2021) / Washington, US	Cross-sectional	Participants who were from three colleges in the Northwest US and ranged in age from 18 to 25. Data were collected within the initial screening survey	N=1181 Random sampling	1,3,4,5	Exploratory factor analysis, multiple linear regression, and zero-inflated Poisson regression (incidence rate ratio)	April 6-June 11, 2020	Cannabis use frequency:"On how many occasions, if any, have you used cannabis (weed, pot) or hashish (hash, hash oil) during the last 30 days?"	To assess distinct domains of COVID-19 repeated stressors using a multifaceted scale and to examine associations between these stressors and indices of mental health, well-being, and	Alcohol	Stressors related to job insecurity, social/relational, and finances were positively correlated with weekly alcohol use and cannabis use frequency. Financial stressors were not

Table 2 (*continued*)

First author (Publication year)/ Country	Study design	Study population	Sample size/type	Topic theme**	Statistical analysis	Recruitment time	Cannabis measurement	Study purpose	Other substance use	Main findings of relevant
		for a longitudinal study						substance use (alcohol and cannabis use)		significant associated with alcohol or cannabis use, and cannabis use frequency was not significantly associated with any of the COVID-19 related stressors in regression models.
Hicks et al. (2022) / Virginia, US	Longitudinal	Participants were a cohort of incoming freshmen at the beginning of fall semester of 2017 that recruited from a large ongoing longitudinal study on college behavioral health at a mid-Atlantic public university	N=323 Voluntary response	1,2,4,5,6	ANOVA, chis-square analyses, and full information maximum likelihood	COVID-19 specific assessment: May-July, 2020Longitudinal study period: 2017 Fall and follow-up online survey each subsequent spring semester	Cannabis use frequency during the past year and since the onset of the COVID-19; Changes in cannabis use from before and during the pandemic (Increased/ decreased/no change)	To examine factors in 4 different aspects and hypothesized poor mental health, negative coping behaviors, negative environmental aspects, and belonging to more vulnerable social groups would be associated with increased substance use during the pandemic	Alcohol, nicotine	Sleep satisfaction was significantly associated with cannabis use, whereby greater sleep satisfaction was associated with lower current frequencies of cannabis use during the pandemic, and negatively associated with using cannabis at a higher frequency compared to the prior assessment before the pandemic.
Leatherdale et al. (2021) / Canada	Longitudinal	Participants were from an ongoing longitudinal study called, The COMPASS Study, a cohort of students in grades 9 through 12. The data used in the study collected from students that attend a convenience sample of 43 schools in Ontario and Quebec.	(N=17,052) n=7567 in the 2018 and n=7548 in 2019, and n=1937 provided data on cannabis use in 2020. Voluntary response	1,2,4	Double-difference models, full information maximum likelihood and structural equation models	Wave 6 (2018); Wave 7 (2019); Wave 8 (2020); Covid-19 assessment: May-July, 2020	Cannabis use frequency (monthly/weekly/ daily use); Cannabis use frequency (never, once, twice, 3 or more times, don't know) when alone; changes of cannabis use (increased, stayed the same/not applicable, decreased)	To assess pre- and early-pandemic data from an ongoing Canadian cohort study of youth to evaluate the effect of COVID-19 during the early stages of the pandemic period on youth cannabis use	Not reported	Monthly, weekly, and daily cannabis use increased across all waves; The expected increases from the pre-COVID wave to the initial COVID-19 period wave were lesser; Females appeared more apt to maintain (or escalate) use relative to males across all cannabis use outcomes modeled at the early stages of the COVID-19 pandemic period.
Miech et al. (2021) / Michigan, US	Longitudinal	Participants were from MTF of US 12th grade students	N=582 MTF: complex multistage sampling designFollow-	1,2,4,5,6	Multivariable logistic regression models and generalized	Baseline: February 2020 and halted prematurely on March, 2020.Follow-up: July-August, 2020	Used cannabis in the past 30 days; easy to get cannabis	To evaluate 4 different hypotheses for 3 high-prevalence forms of substance use: cannabis, binge drinking, and nicotine	Alcohol, nicotine	Perceived availability of cannabis and alcohol declined across two survey waves. Prevalence levels did

Table 2 (*continued*)

First author (Publication year)/ Country	Study design	Study population	Sample size/type	Topic theme**	Statistical analysis	Recruitment time	Cannabis measurement	Study purpose	Other substance use	Main findings of relevant
			up: Voluntary response		estimating equations			vaping and to assess adolescent substance use and availability from the same individuals both before social distancing were implemented		not significantly change across the two waves for cannabis use in the past 30 days; Also, perceived availability of vaping devices significantly declined, as well as nicotine vaping prevalence.
Nguyen et al. (2021) / US	Cross-sectional	Participants were from a national, cross-sectional online survey of adolescents and young adults (13–24 years old)	N=1553 Purposive sampling	1,2,3,4,5	Multivariable logistic regressions (AOR)	May, 2020	Changes in cannabis vaping (increasing/remaining); Use of other cannabis products; dependence on cannabis vaping; risk perceptions of vaping	To assess risk factors for adolescent and young adult cannabis vaping, including risk perceptions of vaping, cannabis vaping dependence, feeling stress or anxiety, and sociodemographic characteristics	Nicotine	Most participants (42.3 %) who had ever vaped cannabis reported no change in their vaping of any substance since the pandemic, 18.3 % reported reducing their vaping of cannabis and/or nicotine, and 6.8 % reported increasing cannabis vaping. Adolescent and young adult ever-cannabis vapers were more likely to report decreasing vaping than increasing cannabis vaping and most did not change use during the early pandemic.
Papp and Kouros (2021) / Wisconsin, US	Longitudinal	Participants were enrolled as a freshman or sophomore when registered; aged 18–21 years old; and reported recent prescription drug misuse of one or more medication	N=295 Voluntary response; Oversample for prescription drug use	1,2,4,5	Descriptive statistics, a repeated-measure ANOVA, and False Discovery Rate	Baseline assessment: September 2017-September 2019COVID-19 assessment: March-April, 2020	Background substance issues; substance use behaviors; craving for cannabis along compulsivity and emotionality	To test direct COVID-19 related changes in emotional and behavioral adjustment in daily life and to identify risk factors that were expected to moderate the extent to which young adults' adjustment in daily life changed across assessment	Alcohol, nicotine, nonmedical purpose of prescription medications (e. g., cocaine, crack, meth, hallucinogens, and heroin)	The risk and non-risk participants did not differ on the hypothesized moderators of loneliness, financial strain, health anxiety, and negative consequences of illness. However, the risk group participants continued to endorse more substance-related outcomes, as reflected by their

Table 2 (*continued*)

First author (Publication year)/ Country	Study design	Study population	Sample size/type	Topic theme**	Statistical analysis	Recruitment time	Cannabis measurement	Study purpose	Other substance use	Main findings of relevant
										relatively higher levels of alcohol consequences and cannabis craving.
Patrick et al. (2021) / US	Longitudinal	12th grade students followed to age 19 who participated in the MTF study and follow-up participants were from MTF Vaping Supplement	N=1244 MTF: complex multistage sampling designFollow-up: Voluntary response	1,2,4,5	Descriptive statistics, and multivariable logistic regression models (AOR)	Baseline: Spring 2019; COVID-19 assessment: September-November 2020	Cannabis use coping; Pre-pandemic past year cannabis use in Spring 2019 (as part of the MTF 12th grade survey)	To examine predictors of using substance to cope with the COVID-19 pandemic, pandemic isolation, stress, economic hardship, demographics, and pre-pandemic substance use	Cigarette, alcohol, prescription and non-prescription drugs, vaping	In Fall 2020, 15.7 % of participants reported using cannabis and COVID-19 related isolation was associated with cannabis use. Pre-pandemic cannabis use was positively associated with cannabis use to cope with the pandemic.
Potvin et al. (2022) / Canada	Cross-sectional	Participants who completed an anonymous online survey and aged 12–25 years old	N=449 Voluntary response	1,2,4,5,6	Descriptive statistics and hierarchical multiple regression analyses	June-July, 2020	Lifestyle habits: frequency of cannabis consumption	To examine the contribution of chronotype and the changes in lifestyle habits during the first wave of the COVID-19 to sleep timing in adolescents and young adults	Alcohol, caffeinated products	Among young adults, cannabis consumption during the pandemic was a predictor of weekend bedtimes. A later chronotype, along with higher usage of electronic devices, as well as higher cannabis consumption during the pandemic were associated with delayed sleep timing during the pandemic.
Sharma et al. (2020) / Wisconsin, US	Cross-sectional	Participants had been seen at one outpatient practice setting over the prior 4.2 months, were aged 18–25 years old of Jan 2020, had a documented email address, and had any indicating including, but not limited to substance use.	N=1018 Voluntary response	1,2,4,5	Descriptive statistics, prevalence estimates, prevalence changes, and prevalence ratios with 95 % confidence intervals	April, 2020	Change in cannabis use since COVID-19 and directionality of change (increase/decrease)	To assess differences between individuals who reported changes in substance use and those who did not in domains of demographic characteristics, self-reported anxiety, depression, loneliness, and substance use and direction of change.	Electronic vaping products, alcohol, tobacco	Among respondents reporting changes in substance use patterns during the pandemic, a split in reported changes by cannabis use (39.2 % increase, 36.0 % decrease). There were no significant differences by report of loneliness, anxiety, or depression for changes in substance use direction when analyzing within

alternative methods of cannabis consumption, such as hand pipe, hookah, bong (Nguyen et al., 2021), and hashish (Graupensperger et al., 2021). However, most other studies did not investigate specific modes of consumption.

3.5. Factors contributing to use

Mental health symptoms were the most commonly reported reasons for increased cannabis use during the pandemic, including depression (Bartel et al., 2020; Bonar et al., 2021; Sharma et al., 2020), stress (Bonar et al., 2021; Clendennen et al., 2021; Graupensperger et al., 2021), anxiety (Bonar et al., 2021; Sharma et al., 2020), loneliness (Bonar et al., 2021; Sharma et al., 2020), and higher current PTSD symptom severity (Hicks et al., 2022). Two studies found that COVID-19-related self-isolation was identified as a significant contributor of cannabis use during the pandemic (Bartel et al., 2020; Patrick et al., 2021). However, some studies noted differently that cannabis use frequency was not significantly associated with any COVID-19 related stressors (e.g., job insecurity, social/relational, financial, illness-related, and school-related), while those with social/relational stressors were more likely to use cannabis (Graupensperger et al., 2021). Additionally, another study indicated that COVID-19 related anxiety was not associated with increases in cannabis use quantity and frequency, whereas pre-pandemic increases in anxiety and depression were significantly associated with increases in cannabis use quantity and frequency during the pandemic (Dyar et al., 2021).

Other factors contributing to cannabis use were also identified across the studies in this review. For example, symptoms of substance-specific dependence (Clendennen et al., 2021; Nguyen et al., 2021), pre-pandemic cannabis use (Patrick et al., 2021), and perceptions related to cannabis use (e.g., that cannabis is safer than smoking cigarettes), were associated with increased cannabis use (Nguyen et al., 2021).

3.6. Substance use other than cannabis during the COVID-19 pandemic

In addition to cannabis, a total of 13 articles (87 %) investigated substances other than cannabis, including alcohol **(n=11)** (Bonar et al., 2021; Dumas et al., 2020; Dyar et al., 2021; Graupensperger et al., 2021; Hicks et al., 2022; Miech et al., 2021; Papp and Kouros, 2021; Patrick et al., 2021; Potvin et al., 2022; Sharma et al., 2020; Tucker et al., 2020), nicotine **(n=5)** (Bonar et al., 2021; Hicks et al., 2022; Miech et al., 2021; Nguyen et al., 2021; Papp and Kouros, 2021), vaping **(n=5)** (Dumas et al., 2020; Patrick et al., 2021; Sharma et al., 2020; Tucker et al., 2020), tobacco **(n=3)** (Bonar et al., 2021; Sharma et al., 2020; Tucker et al., 2020), cigarette **(n=2)** (Clendennen et al., 2021; Patrick et al., 2021), nonmedical use of prescription medication **(n=2)** (Papp and Kouros, 2021; Patrick et al., 2021), e-cigarette **(n=2)** (Clendennen et al., 2021; Sharma et al., 2021), and caffeine products **(n=1)** (Potvin et al., 2022), which reflect the fact that polysubstance use is common among adolescents and young adults.

The majority of the studies in this review assessed the prevalence of other substances besides cannabis. Similarly to the findings concerning cannabis, the prevalence of other substances varied across the studies; this was likely due to the heterogeneous nature of the studies, their participants, and their designs. Some studies showed that more participants reported sustained or decreased alcohol use than increased alcohol use when comparing the pre-COVID to COVID periods (Bonar et al., 2021; Hicks et al., 2022), while some studies noted more participants reported increased alcohol use (Dumas et al., 2020; Miech et al., 2021). Two studies investigated binge drinking and showed decreased use when comparing pre-COVID to COVID periods (Dumas et al., 2020; Miech et al., 2021). Nicotine use varied and some studies reported no change or decreased use (Bonar et al., 2021; Hicks et al., 2022; Miech et al., 2021; Nguyen et al., 2021; Papp and Kouros, 2021). No changes were found for cigarettes (Clendennen et al., 2021; Patrick et al., 2021),

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Table 2 (*continued*)

First author (Publication year)/ Country	Study design	Study population	Sample size/type	Topic theme**	Statistical analysis	Recruitment time	Cannabis measurement	Study purpose	Other substance use	Main findings of relevant
Tucker et al. (2020) / California, US	Cross-sectional	Participants who enrolled in an ongoing evaluation of a substance use and sexual risk reduction intervention for 18–25 years old experiencing homelessness	N=90 Voluntary response	1,2,4,5	Descriptive statistics	Covid-19 assessment: April-July, 2020	How the COVID-19 had affected their use of cannabis	To assess how the COVID-19 affect emerging adults currently or recently homeless in terms of engagement in protective behaviors, mental health, substance use, and access to service	Alcohol, tobacco	substance type groups. Among those who had used substances before the outbreak, 16 % reported increased alcohol use, 20 % increased tobacco use, and 28 % increased cannabis use.

* Abbreviations: AOR= adjusted odds ratio; BCAMM=Brief Cannabis Motives Measure; COMPASS= The Cannabis use, Obesity, Mental health, Physical activity, Alcohol use, Smoking, and Sedentary behavior; MTF=Monitoring the Future; TATAMS= Texas Adolescent Tobacco and Marketing Surveillance Study; UOR=unadjusted odds ratio.

** 1- Prevalence and trends of cannabis use during the COVID-19 pandemic; 2- demographics; 3- mode of consumption; 4- factors contributing to use; 5- Substance use other than cannabis during the COVID-19 pandemic; and 6- Other important findings.

Table 3
Risk of bias assessment of included cohort studies.*

First author (Publication year)	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Overall Appraisal
Bartel et al. (2020)	Y	U	U	Y	Y	Y	U	U	U	U	Y	Included
Dyar et al. (2021)	Y	Y	Y	Y	Y	U	Y	U	Y	Y	Y	Included
Hicks et al. (2022)	Y	Y	Y	Y	N	U	Y	U	N	Y	Y	Included
Leatherdale et al. (2021)	Y	Y	Y	Y	Y	U	Y	U	N	Y	Y	Included
Miech et al. (2021)	Y	Y	N	U	Y	U	Y	U	N	Y	Y	Included
Papp and Kouros (2021)	Y	Y	Y	Y	Y	Y	Y	U	Y	Y	Y	Included
Patrick et al. (2021)	Y	Y	U	Y	Y	N	Y	U	N	N	Y	Included

Abbreviations: Y=Yes; N=No; U=Unclear
Q1: Were the two groups similar and recruited from the same population?
Q2: Were the exposures measured similarly to assign people to both exposed and unexposed groups?
Q3: Was the exposure measured in a valid and reliable way?
Q4: Were confounding factors identified?
Q5: Were strategies to deal with confounding factors stated?
Q6: Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?
Q7: Were the outcomes measured in a valid and reliable way?
Q8: Was the follow up time reported and sufficient to be long enough for outcomes to occur?
Q9: Was follow up complete, and if not, were the reasons to loss to follow up described and explored?
Q10: Were strategies to address incomplete follow up utilized?
Q11: Was appropriate statistical analysis used?
    * The risk of bias tool was obtained from JBI cohort study critical appraisal checklist. More detailed of each checklist is available to the Appendix Fig. 1.

Table 4
Risk of bias assessment of included cross-sectional studies.*

First author (Publication year)	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Overall appraisal
Bonar et al. (2021)	Y	Y	Y	Y	N	N	Y	Y	Included
Clendennen et al. (2021)	Y	Y	Y	U	Y	Y	Y	Y	Included
Dumas et al. (2020)	Y	Y	Y	U	Y	Y	U	Y	Included
Graupensperger et al. (2021)	Y	Y	Y	U	Y	Y	Y	Y	Included
Nguyen et al. (2021)	Y	Y	U	U	Y	Y	U	Y	Included
Potvin et al. (2022)	Y	Y	U	U	N	U	U	Y	Included
Sharma et al. (2020)	Y	Y	Y	U	N	N	Y	Y	Included
Tucker et al. (2020)	Y	Y	U	U	N	N	U	Y	Included

Abbreviations: Y=Yes; N=No; U=Unclear
Q1: Were the criteria for inclusion in the sample clearly defined?
Q2: Were the study subjects and the setting described in detail?
Q3: Was the exposure measured in a valid and reliable way?
Q4: Were objective, standard criteria used for measurement of the condition?
Q5: Were confounding factors identified?
Q6: Were strategies to deal with confounding factors stated?
Q7: Were the outcomes measured in a valid and reliable way?
Q8: Was appropriate statistical analysis used?
    * The risk of bias tool was obtained from JBI cross-sectional critical appraisal checklist. More detailed of each checklist is available to the Appendix Fig. 2.

e-cigarettes (Clendennen et al., 2021; Sharma et al., 2021), and prescription medication (Papp and Kouros, 2021). However, one study did not report the types of nicotine use, which included cigarettes, e-cigarettes, and chewing tobacco (Papp and Kouros, 2021), and another study did not provide a clear definition of vaping (Patrick et al., 2021).

Anxiety and depression were associated with increased in alcohol use (Dyar et al., 2021), and social/relational stressors were associated with greater likelihood of heavy episodic drinking, but not for weekly alcohol use (Graupensperger et al., 2021). Additionally, social context (e.g., with friends, with parents, etc.) was significantly associated with frequency of both alcohol use and binge drinking (Dumas et al., 2020). Other risk factors of increased substance use were identified. For example, females reported a greater occurrence of prescription misuse in daily life (Papp and Kouros, 2021). The changes in sleep schedules during the pandemic were associated with increased caffeine consumption among 12–17 years old adolescents (Potvin et al., 2022). Additionally, those who had substance-specific dependence were more likely to report increasing use of e-cigarettes due to the pandemic (Clendennen et al., 2021).

3.7. Other important findings

One study differentiated cannabis from Cannabidiol-only (CBD) products (Bonar et al., 2021). In that study, CBD use was stable for approximately 60 % of participants who used CBD both before and during the pandemic. Two studies addressed the changes in sleep habits or sleep satisfaction during the pandemic (Hicks et al., 2022; Potvin et al., 2022). Cannabis use during the pandemic was associated with later weekend bedtimes (Potvin et al., 2022), whereas greater sleep satisfaction was significantly associated with lower cannabis use frequency during the pandemic (Hicks et al., 2022). Due to the social distancing policies and regulations during the COVID-19 pandemic, the decreased prevalence of cannabis use during the pandemic might reflect the decreased perceived cannabis availability (Miech et al., 2021). Additionally, only one study included in this review asked participants about the status of legalization within the state and involved group-based interventions and control conditions, separately categorizing them by age and state of residence, with or without legal recreational cannabis (Bonar et al., 2021). All other studies that specified a state except Texas, as well as Canada, in this review, are from regions where both medical and recreational cannabis use was legal (National

Conference of State Legislatures, 2023).

4. Discussion

The purpose of this systematic review was to summarize the prevalence of cannabis use among adolescents and young adults during the COVID-19 pandemic from the recent literature, as well as to determine the reasons behind cannabis use in this population and how cannabis use patterns changed among adolescents and adults during the pandemic. This systematic review included 15 articles which reported the results of studies conducted in the US and Canada. While there is evidence that drug use, in general, increased during the COVID-19 pandemic (Czeisler et al., 2020), this review showed conflicting evidence regarding whether cannabis use increased during the pandemic for adolescents. Several studies identified social isolation, loneliness, and mental health symptoms (e.g., depression, anxiety) as reasons why adolescents may have changed their cannabis consumption patterns during the COVID-19 pandemic.

The prevalence of self-reported cannabis use among youth in the pandemic were conflicting among the studies included in the review and these conflicting results may reflect differential measurements of cannabis consumption and heterogeneity in the study population. The studies used different measures of cannabis use that specified different recall periods (monthly, weekly, daily, the last 30 days, the last 3 weeks, and the past year). Additionally, the studies collected data at different periods, such as having a baseline assessment done before the pandemic or recruiting study participants at an early or later stage of the pandemic. For example, one study suggested that several sociodemographic sub-groups reported increased cannabis use in April, May, and June in 2020 when compared cannabis use at the first of each month to the baseline assessment (March 2020). Furthermore, while most of the cannabis use measurements were obtained from psychometrically validated instruments, the measures relied on self-reported cannabis use, which might be subject to recall bias or reporting bias and may not accurately reflect the true prevalence of cannabis use. Lastly, although not all studies estimated the prevalence of cannabis use, different study population characteristics (i.e., college-aged young adults who experiencing homelessness (Tucker et al., 2020), general college student populations (Graupensperger et al., 2021; Hicks et al., 2022; Papp and Kouros, 2021), outpatient setting (Sharma et al., 2020), self-identified sexual minorities (Dyar et al., 2021), and any self-reported prior substance use (Bartel et al., 2020; Bonar et al., 2021; Clendennen et al., 2021; Dyar et al., 2021; Papp and Kouros, 2021; Sharma et al., 2020; Tucker et al., 2020)) among the articles included in this review, may also suggest different patterns of cannabis use in response to the pandemic.

The mixed findings related to whether cannabis use increased or declined during the pandemic requires additional research and further exploration. Given the limited number of studies in this review and conflicting findings, it might be challenging to identify the true prevalence of cannabis use among this population due to the methodologies, ages, and geographic differences of the populations that were highlighted in this review. The declining rates of cannabis use during the pandemic could reflect limited accessibility of cannabis due to decreased availability and access to cannabis and increased time spent at home with parents/caregivers. Two studies examining 2020 sales data in Canada and four US states with legal recreational cannabis laws (Alaska, Colorado, Oregon, and Washington) showed cannabis sales increased during the pandemic (MacKillop et al., 2021; Schauer et al., 2021). However, it is unclear how the cannabis sales changed and how the availability of cannabis products was impacted in states without legal cannabis options during the pandemic among adolescents and young adults. Furthermore, adolescents and young adults with pre-existing mental health problems may have experienced an exacerbation of their mental health symptoms due to the pandemic restrictions and further increased their use of cannabis as a coping mechanism. Emerging research has indicated that symptoms of depression, anxiety, and

substance misuse significantly increased among adolescents, while social support and connection fell significantly (Gazmararian et al., 2021; Magson et al., 2021). Several factors suggest that certain youth subgroups, such as sexual minorities, may have been more susceptible to cannabis use prior to the pandemic (Gonzales, 2020) and had higher prevalence of poor mental health prior to (Semlyen et al., 2016) and during the pandemic (Fish et al., 2021).

The main strength of this review is that it addressed an important public health issue related to cannabis use among adolescents and young adults by investigating whether patterns of cannabis use changed during the pandemic among this population and discussing methodological differences of the studies included in this review. This is important as policy and legalization efforts evolve and the availability of legal cannabis increases. This review also included some "grey literature" (i. e., thesis and dissertations), which can significantly improve systematic review findings by lessening publication bias, enabling a more impartial analysis of the review of evidence, and disseminating null or negative results (Benzies et al., 2006).

Although this review followed the PRISMA guidelines, it is not without limitation. First, this review was limited to publications written in English from library databases, and articles published after January 2022 were not included in this review. Therefore, government reports and articles in other languages were not included, which may result in reduced generalizability. Second, studies without full texts were not included in this review. However, only two articles met this criterion and are not likely to impact study findings. Next, the findings of this systematic review should be interpreted with caution due to different study designs and different cannabis use measurements. Most studies used non-probability sampling methods, which may limit the external validity of the findings. In addition, this review limited study populations up to age 25, which may lead to some confusion in the terminology of adolescents and young adults. For this reason, this review may have missed some studies that also assessed prevalence in cannabis use but were classified as young adults who were older than 25. While the use of alcohol and cannabis is common among young individuals (Lee et al., 2022), only two studies in this review investigated concomitant use of cannabis and alcohol use (Dyar et al., 2021; Hicks et al., 2022). Lastly, the results may not generalize to states or countries where cannabis remains illegal. There is a lack of information in the studies included in this review regarding cannabis legislation in the participants' states of residence, especially for those studies that enrolled participants from across the entire US. Although Texas currently only permits low levels of THC in medical cannabis and still considers the recreational use of cannabis illegal, all other studies that specified a state, as well as Canada, in this review, are from regions where both medical and recreational cannabis use is legal.

Several implications for prevention should be considered. First, the findings that associated cannabis use with mental health issues among adolescents and young adults suggest that secondary schools and universities could consider providing prevention and treatment programs related to cannabis use and mental health. One study found a significant upward trend of counseling request for psychotic symptoms among adolescents during the pandemic (Petruzzelli et al., 2022), which suggests the necessity of heightened demand for therapeutic intervention programs among young people who are vulnerable to mental health issues. Therefore, it is necessary for schools and universities to provide a safe place for those students to access campus mental health services and re-establish social connections that were lost during the pandemic due to social restrictions to prevent depression and isolation. Additionally, there is still a need to continue public health surveillance to monitor changes in cannabis use. As students have returned to schools with less restrictive social distancing, cannabis availability may have returned to "normal" for the population who may have had restricted access to cannabis during the pandemic. The conflicting results in this systematic review suggested multifaceted reasons behind the trends of cannabis use among this population. These include factors such as increased drug

access due to the legalization, shifting social norms or perceptions of harm, and varied public education related to cannabis, and differences in study designs and/or analyses. Consequently, gaining a comprehensive understanding of the long-term impacts of cannabis use and effectively reducing its prevalence among adolescents and young adults necessitates both surveillance and additional prospective measures. It is essential to address multiple aspects, such as evaluating the extent of cannabis access and availability, disseminating accurate and trustworthy public information about cannabis, and implementing substance use prevention programs in schools and colleges. Lastly, future research may consider replicating the results in countries or states where cannabis is not legal and distinguishing the factors contributing to the use of cannabis where it is and is not legal.

This systematic review summarized cannabis use among adolescents and young adults during the pandemic. Among the 15 studies included, this review determined that the findings on the prevalence of cannabis use during the COVID-19 pandemic are mixed, and mental health issues related to the pandemic were associated with increased cannabis use. Future surveillance is warranted to understand the long-term effects on cannabis use among adolescents and young adults that may have occurred due to the pandemic.

Compliance and ethical standards

There are no human or animal participants in this article and informed consent is not applicable.

Note: YT has moved to a new institution after completing the research. The address of the new institution has been provided on the title page.

CRediT authorship contribution statement

Toni M. Rudisill: Writing – review & editing, Supervision, Conceptualization. **Christa L. Lilly:** Writing – review & editing. **Christiaan G. Abildso:** Writing – review & editing. **Erin L. Winstanley:** Writing – review & editing. **Brenna Kirk:** Formal analysis. **Folawiyo Olanrewaju:** Formal analysis. **Yuni Tang:** Writing – original draft, Writing - review & editing, Methodology, Formal analysis, Conceptualization.

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Declaration of conflicting interests

YT serves as a panel member for the Behavioral Traffic Safety Cooperative Research Program (BTSCRP), Transportation Research Board (TRB), 2023 BTS-32 *Formative Research and Resources to Prevent Cannabis Impaired Driving Among Teens and Young Adults*. All other co-authors declare that there is no conflict of interest.

Declaration of Generative AI and AI-assisted technologies in the writing process

Nothing declared.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.dadr.2024.100232.

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