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Does liberalisation of cannabis policy influence levels of use in adolescents and young adults? A systematic review and meta-analysis

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ABSTRACT

Objectives To examine the effect of cannabis policy liberalisation (decriminalisation and legalisation) levels of use in adolescents and young adults.

Design Systematic review and meta-analysis.

Inclusion criteria Included studies were conducted among individuals younger than 25 years and quantitatively assessing consequences of cannabis policy change. We excluded articles: (A) exclusively based on participants older than 25 years; (B) only reporting changes in perceptions of cannabis use; (C) not including at least two measures of cannabis use; (D) not including quantitative data; and (E) reviews, letters, opinions and policy papers. PubMed, PsycINFO, Embase and Web of Science were searched through 1 March 2018.

Data extraction and synthesis Two independent readers reviewed the eligibility of titles and abstracts and read eligible articles, and four authors assessed the risk of bias (Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies). Extracted data were meta-analysed. The protocol was registered with PROSPERO.

Results 3438 records were identified via search terms and four via citation lists; 2312 were retained after removal of duplicates, 99 were assessed for eligibility and 41 were included in our systematic review. 13 articles examined cannabis decriminalisation, 20 examined legalisation for medical purposes and 8 examined legalisation for recreational purposes. Findings regarding the consequences of cannabis decriminalisation or legalisation for medical purposes were too heterogeneous to be meta-analysed. Our systematic review and meta-analysis suggest a small increase in cannabis use among adolescents and young adults following legalisation of cannabis for recreational purposes (standardised mean difference of 0.03, 95% CI −0.01 to −0.07). Nevertheless, studies characterised by a very low/low risk of bias showed no evidence of changes in cannabis use following policy modifications.

Conclusions Cannabis policy liberalisation does not appear to result in significant changes in youths' use, with the possible exception of legalisation for recreational purposes that requires monitoring.

Trial registration number CRD42018083950.

Strengths and limitations of this study

- ► To date, this is the first study to attempt to summarise research on the consequences of various types of changes in cannabis laws and policies (decriminalisation as well as different forms of legalisation) with regard to patterns of use among adolescents and young adults.
- ► Various data sources in the fields of public health, economics and public policy were searched in a systematic way.
- ► The duration of follow-up varied across studies, partly because changes in cannabis policy occurred in different periods and places.
- ► Among studies examining the consequences of the legalisation of cannabis for recreational purposes, only one was characterised by a very low risk of bias and five by a low risk of bias; therefore, the findings will need to be confirmed in future research.

INTRODUCTION

Cannabis is one of the most frequently used psychoactive substances in North America, Europe, Oceania and North Africa (12 month prevalence of 3.8% in the world).[1] Since the 1961 Single Convention on Narcotic Drugs, cannabis is illegal in most countries. However, in the past 20 years, a majority of US states (31 including the District of Columbia) and several countries (eg, Spain, Uruguay and Portugal) have liberalised their cannabis legislation by decriminalising or legalising use for medical or recreational purposes.[2] Decriminalisation is the reduction of penalties for cannabis use while maintaining penalties for cannabis supply. Legalisation is the permission to use and supply oneself (via home growing or controlled sale). Legalisation for medical use is permission to use and sometimes supply with the involvement of a medical professional (eg, with a doctor's prescription or recommendation).[3]

In many settings—especially where cannabis is widely used—public support for legalisation is widespread.[4 5] For cannabis users, decriminalised or regulated access to the substance decreases the legal and criminal risks incurred. Potential collective benefits of cannabis policy liberalisation include: (A) reduced law enforcement costs, (B) improvements in the quality of the substance used and (C) in case of commercial legalisation, additional tax revenue.[6]

Still, cannabis is a source of addiction and can have deleterious health consequences in the short and long terms, including impairments in memory and concentration,[7] risk of injury or respiratory problems.[8] Moreover, liberalised access to cannabis could also influence the levels of use of other psychoactive substances (eg, tobacco and alcohol).[9 10] At the same time, there is also evidence that in the USA, the recent increase in opioid use is less marked in states that recently implemented policies liberalising cannabis regulations.[11]

In adults, the liberalisation of cannabis policy has been followed by increases in levels of heavy cannabis use.[12–15] This may be driven by reductions in the perceived risks,[16] price decreases, as well as increases in cannabis availability.[13 15] However, in adolescents who may be especially vulnerable to the negative consequences of cannabis,[7] the impact of policy liberalisation is unclear.[13] As additional US states and European countries are considering liberalising cannabis legislation, there is need to evaluate the potential public health consequences of such policy change.

The objectives of this study were to gain better understanding of the influence of changes in cannabis policy on patterns of use among adolescents and young adults. Youths are a high-risk group in terms of illegal substance use and may be especially sensitive to changes in policy; at the same time they may also be especially vulnerable to the biological, psychological and behavioural consequences of cannabis. Data published before 1 March 2018 on this topic were systematically reviewed and meta-analysed.

METHODS

Search strategy

Following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines,[17] we conducted a systematic review of studies testing quantitative differences in cannabis use among adolescents and young adults before and after policy change, published prior to 1 March 2018.

Specifically, the following search terms were introduced in PubMed, Web of Science, Embase and PsycINFO: (law* OR decriminalisation OR legalisation) AND (cannabis OR pot OR weed OR marijuana OR grass) AND (young OR youth OR adolescen* OR teen* OR school* OR student). Searches were specified for both MeSH (Medical Subject Headings) terms and text words and were modified to meet the requirements of each database. Only articles in English were identified. All titles and abstracts were independently screened by two of the authors to determine potential eligibility. Full texts of all potentially eligible studies were read by two of the authors (FH and MADS) and discussed with all other authors in case of disagreement. The protocol was registered in PROSPERO and followed the PRISMA framework.[17] The full search strategy is detailed in online supplementary material figure 1.

Inclusion criteria

To be included, studies had to be conducted among individuals younger than 25 years and quantitatively assess whether cannabis policy change (defined as decriminalisation or legalisation of cannabis use for medical or recreational purposes) as compared with no change or the situation prior to change was associated with changes in cannabis use. This age limit was selected as it is a meaningful cut-off for the potentially negative biological and social effects of cannabis[7] as well as a frequently used upper bound to define young people. We excluded articles: (A) exclusively based on participants older than 25 years; (B) only reporting changes in perceptions of cannabis use; (C) not including at least two measures of cannabis use and which did not make it possible to compare changes between before and after policy change; (D) not including quantitative data; and (E) reviews, letters, opinions and policy papers.

Patient and public involvement

This research was based on analyses of previously published studies and did not involve direct patient involvement.

Risk of bias

In order to judge the quality of studies that were analysed, risk of bias was assessed using the Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies developed by the National Institute of Health (https://www.nhlbi.nih.gov/health-pro/guidelines/in-develop/cardiovascular-risk-reduction/tools/cohort). Four independent raters evaluated each study (two per article) on up to 11 items including characteristics of the study population, exposure and outcome measurement, time frame adequacy, loss to follow-up (cohort studies; <20% being considered as associated with low bias) and adjustment for confounders. Studies defined as presenting a very low risk of bias had no identified flaws. Studies characterised 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 characterised 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 characterised by two or more of the risks identified above. Differences in ratings between coders were discussed in joint meetings.

Data extraction

A coding sheet was developed to identify: study authors, place of study, type of policy change/study period, participant characteristics (ns), study design, cannabis use measure, statistical methods used/covariates controlled for, key findings and risk of bias.

Meta-analysis

To meta-analyse the effects of the liberalisation of cannabis policy on levels of use, we calculated standardised mean differences and associated 95% CIs for each finding using the Practical Meta-Analysis Effect Size Calculator.[18] Effects sizes from different studies were combined into a weighted mean effect size. Each effect size was weighted by the inverse of its variance and then averaged.[19] Standard meta-analytical procedures suppose the independence of effects.[20] However, several primary studies provided multiple correlated effect size estimates for the same underlying outcome (eg, 30-day use and 12-month use). To avoid the loss of information resulting from the selection of only one effect size per study, we used the robust variance estimation method,[21] which makes it possible to handle statistically dependent effect sizes. A fixed effect meta-analysis was undertaken in the absence of significant heterogeneity; otherwise, a random effects model was used.[22] To test for homogeneity, we computed the Q statistic to determine whether each set of effect sizes shared a common population effect size.[19] To interpret between-study heterogeneity, we used the I^2 statistic; an $I^2 \leq 50\%$ is generally considered to indicate low heterogeneity.[23]

To study whether cannabis use in adolescents and young adults varied as a function of: (1) cannabis decriminalisation, (2) legalisation of cannabis use for medical purposes or (3) legalisation of cannabis use for recreational purposes, we conducted three main meta-analyses.

For each type of cannabis policy change, we also performed a priori hypothesised subgroup analyses, according to study design (cohort vs cross-sectional), study year (<2000 vs ≥2000), participants' age (<18 years vs ≥18 years) and the measure of cannabis use (30-day use vs 12-month use). Studies included in this review did not present stratified results based on whether participants were <21 years versus ≥21 years (the legal age for cannabis use in US states that legalised the substance), making it impossible for us to conduct sensitivity analyses using this age cut-off.

Finally, because the results of a meta-analysis can be biased by studies with non-significant results being less likely to be published, we examined publication bias graphically, using a funnel plot. All analyses were performed using STATA V.14.0 and the *robumeta* macro.[24]

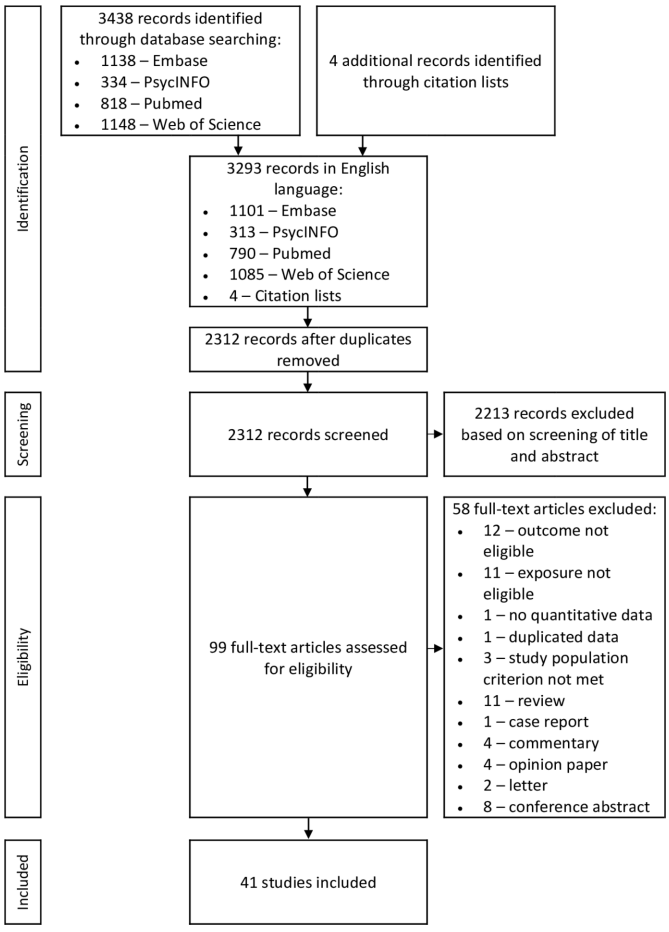

Figure 1 Flow chart showing the screening and selection process of articles selected for the study of the impact of liberalisation of cannabis policy with regard to levels of use in adolescents and young adults.

RESULTS

The study flow chart (figure 1) shows our search strategy that resulted in the identification of 41 original research reports to be analysed.

The 41 studies analysed were all published in English: 33 were conducted in the USA,[10 25–56] 3 in Australia,[57–59] 2 in the UK,[60 61] 1 in the Netherlands,[62] 1 in the Czech Republic[63] and 1 internationally.[54] Thirteen studies evaluated the consequences of cannabis decriminalisation,[25–28 37 54 57–63] 20 studies evaluated the consequences of legalisation of use for medical purposes[10 29–36 38–45 49 53 54] and 8 studies evaluated the consequences of legalisation of use and possession for recreational purposes.[46–48 50–52 55 56] All studies examining the effects of cannabis legalisation (for medical or recreational purposes) were based in the USA.

The reports included were heterogeneous in terms of the populations studied: 21 focused on adolescents (12–17 years),[25 28 31 33–35 38 41–44 46–50 53–55 60] 6 on young adults (18–25 years)[37 40 52 56 57 59] and 14 included data on both of these groups.[14 26 27 29 30 32 36 39 45 51 57 60–62]

Among studies conducted in the USA, nine were based on the National Study on Drug Use and Health (NSDUH) conducted by the Substance Abuse and Mental Health

Services Administration (https://nsduhweb.rti.org/respweb/homepage.cfm),[14 31 32 36 39 42–45] seven on the Monitoring The Future study (MTFS; http://monitoringthefuture.org/),[10 25 28 37 38 41 50] four on the Youth Behavioral Risk Surveillance survey (YBRS; https://www.cdc.gov/healthyyouth/data/yrbs/index.htm)[33–35 49] and four on the National Longitudinal Survey of Youths (NLSY79; https://www.nlsinfo.org/content/cohorts/nlsy79,[26 27] and NLSY97 https://www.nlsinfo.org/content/cohorts/nlsy97.[33 40]

Among studies conducted in Australia, two were based on the National Drug Strategy Household Survey (http://data.gov.au/dataset/national-drugs-strategy-household-survey).

Thirty-four studies were based on repeated cross-sectional data,[10 25 28 29 31–39 41–45 48–59 61–63] six on longitudinal cohort data[26 27 40 46 47 60] and one on analyses of routine administrative data.[30] Sample sizes in individual studies ranged from n=336[30] to >11 703 100.[35]

Overall, 16 studies were characterised by a very low risk of bias[10 14 31 32 34–36 38 41 44 45 49 50 57 58 62] and 9 by a low risk of bias[26 27 30 47 48 51–54]; in our systematic review, only the results of these investigations were analysed. Given the small number of articles in each category, all studies except those with a high level of bias were meta-analysed. In additional analyses, we verified that findings were stable when studies characterised by probable bias were excluded.

Decriminalisation of cannabis use

As shown in table 1, among the 13 studies examining the consequences of cannabis decriminalisation, three were characterised by a very low risk of bias.[57 58 62] Two of these—one based in Australia (n=15 468) and the second in the Czech Republic (n=1524), and both conducted among adolescents and young adults—found no evidence of statistically significant changes in patterns of cannabis use following policy change.[57 62] However, one study—based in Australia and conducted exclusively among adolescents aged 12–17 years (n=39 0387)—observed a 12% increase in use following cannabis decriminalisation.[58] We also identified one study characterised by a low risk of bias[26]conducted in the USA and focusing on 14–21 year olds (n=12 686)—which observed no statistically significant effect of cannabis decriminalisation on youths' use.

Meta-analysing all 13 studies, we observed an I^2 of 99.5%, indicating high heterogeneity. After excluding studies conducted by Williams and Bretteville-Jensen[58] and Miech *et al*[37] (online supplementary figures 1A,B), which appeared to be outliers, the I^2 was reduced to 99.1% but remained too high to conduct a robust meta-analysis. This was unchanged when the analysis was restricted to cohort study data, study year (<2000 or ≥2000), a particular age group (12–17 years or 18–25 years) or recent cannabis use (30 days).

Legalisation of cannabis use for medical purposes

As shown in table 2, 20 studies examined the consequences of the legalisation of cannabis use for medical purposes in the USA from 1996 onwards. Twelve were characterised by a very low risk of bias.[10 31 32 34–36 38 41 44 45 49] Of those, six were based on NSDUH data,[14 31 32 36 44 45] three on the YRBS[34 35 49] and three on the MTFS.[10 38 41] Altogether, six studies (n ranging from 11 453 to 11 703 100)—all conducted among adolescents—one additionally including youths aged 18–20 years[36] and one additionally including youths aged 18–25 years[45]—found no statistically significant effect of the introduction of medical cannabis laws.[34–36 38 44 45] Three of these studies were based on NSDUH data[36 44 45] and two on the YRBS.[34 35] Importantly, both the NSDUH and the YRBS being repeated cross-sectional surveys, the analytical methods used vary across reports in terms of length of follow-up after policy change (from 1 to 9 years), statistical methods (logistic regression,[45] difference-in-differences[35] and fixed-effects models[36]), as well as covariates. Still, all studies characterised by a very low risk of bias are adjusted for individual demographic characteristics (age, sex and race) as well as contextual factors (at minima a state identifier and the level of cannabis use prior to policy change). In three studies conducted among adolescents, the legalisation of medical cannabis was followed by a decrease in use.[32 41 49] These three reports were based on different large datasets (NSDUH,[32] MTFS[41] and YRBS,[49] with ns ranging from 11 813 to 973 089). Finally, three studies (ns ranging from 11 813 to 973 089) observed an increase in levels of cannabis use among adolescents (under 18 years) living in a state that passed medical cannabis laws[10 14 31] and one of these observed a similar effect among young adults (ages 18–25 years).[14]

Two studies were characterised by a low risk of bias.[30 53] One, based on routine data (Arrestee Drug Abuse Monitoring system, n=336), showed no statistically significant differences in the prevalence of cannabis use (as ascertained by urine tests) among persons seen in hospital emergency departments before and after medical cannabis laws.[30] The second study reported that among cannabis users recruited via social media (n=2630), the level of cannabis vaping and eating varied with the time since legalisation of medical cannabis—the longer the time since legalisation, the higher the likelihood of use.[53]

Importantly, these data indicate that the provisions of laws enabling access to cannabis for medical purposes, such as the amount of cannabis that individuals are allowed to possess and use, the existence of patient registries,[49] the proportion of dispensaries per inhabitant, the authorisation of home cultivation or concomitant laws making it legal to use cannabis for recreational purposes,[53] are influential and should be systematically reported by researchers examining the effects of cannabis policies.

Meta-analysing all 20 studies, we observed an I^2 of 100%, indicating high heterogeneity. After excluding the studies conducted by Wen *et al*[36] and Harper *et al*,[32] which

Table 1 Studies examining cannabis use levels in adolescents before and after decriminalisation of cannabis possession (1981–2017)

Study	Place of study	Type of policy change/study period	Participant characteristics/n	Study design	Cannabis use measures (frequency/period)	Statistical methods/ covariates	Key findings/effect size	(Rater 1 (R1); rater 2 (R2)) (/10)
Johnston *et al*[25]	California, Maine, Minnesota, Ohio (early change)+North Carolina, New York and Missouri (late change) versus states with no decriminalisation.	Decriminalisation of cannabis possession in 1975 and 1976.	12th grade students participating in the Monitoring the Future surveys (MTFS)/ n~99 000 per year.	Cross-sectional survey (1975–1980).	12 months, 30 days and daily use.	Comparisons of prevalence rates.	12-month use: d=0.06, 95% CI 0.0003 to 0.127; 30-day use: d=0.125, 95% CI 0.059 to 0.191 (unadjusted).	R1: 8. R2: 8.1. Average: 8.1. Possible.
Thies and Register[26]	Alaska, California, Colorado, Maine, Minnesota, Missouri, Nebraska, New York, North Carolina, Ohio and Oregon.	Decriminalisation of cannabis possession 1976–1979.	14–21 year olds participating in the National Longitudinal Study of Youths 1979 (NLSY) /n=12 686.	Cohort study with follow-up in 1984 and 1988.	30-day use.	Ordinary Least Squares (OLS) regression models controlled for sex, race, parental education, own education, income, church attendance, marital status, urban setting; legal context regarding underage drinking.	1984: d=0.05, 95% CI −0.02 to 0.14; 1988: d=0.06, 95% CI −0.03 to 0.16 (unadjusted).	R1: 9. R2: 9. Average: 9. Low.
McGeorge and Aitken[56]	Australian Capital Territory versus Melbourne.	Decriminalisation of cannabis possession, use and cultivation in 1992.	Third-year university students at Australian National University and Melbourne University /n=903.	Cross-sectional survey (1994).	12-month use.	χ^2 statistics.	d=0.21, 95%–0.02 to 0.45 (unadjusted).	R1: 6.4. R2: 4.5. Average: 5.5. Probable.
MacCoun and Reuter[61]	The Netherlands.	Decriminalisation of cannabis in 1976 followed by legalisation in 1984.	16–18 year olds participating in a school-based survey (Trimbos) versus youths of the same age in the USA (Monitoring the Future)/ n~115 000.	Repeated cross-sectional surveys: 1970–1996.	Lifetime use.	Comparison of prevalence rates.	The Netherlands versus USA: d=−0.23; 95% CI −0.26 to −0.19 (unadjusted).	R1: 8.1. R2: 8.2. Average: 8.2. Possible.
Pacula[27]	Alaska, California, Colorado, Maine, Minnesota, Missouri, Nebraska, New York, North Carolina, Ohio and Oregon.	Decriminalisation of cannabis possession 1976–1979.	14–21 year olds participating in the NLSY/ n=8008.	Cohort study with follow-up in 1984.	30-day use.	Two part model controlled for sex, age, race, number of siblings, urban setting, academic achievement, expected years of schooling, illegal activity; parents' marital status, employment status, alcohol use; legal context regarding alcohol use, crime level, beer and cigarette taxes.	d=0.0179, 95% CI −0.038 to 0.0008.	R1: 10.0. R2: 8.1. Average: 9.1. Low.
DiNardo and Lemieux[28]	California, Colorado, Maine, Minnesota, Mississippi, Nebraska, New York, North Carolina, Ohio and Oregon.	Decriminalisation of cannabis possession 1976–1979.	12th grade students participating in the MTF /n~165 000.	Cross-sectional survey (1980–1989).	30-day use.	Structural regression model controlled for sex, age, race, parental education, weekly hours of work, income, alcohol use, state-level unemployment and alcohol drinking age.	d=−0.08, 95% CI −0.12 to −0.05.	R1: 7.7. R2: 7.7. Average: 7.7. Possible.

Continued

Table 1 Continued

Study	Place of study	Type of policy change/study period	Participant characteristics/n	Study design	Cannabis use measures (frequency/period)	Statistical methods/ covariates	Key findings/effect size	(Rater 1 (R1); rater 2 (R2)) (/10)
Williams[57]	Australian Capital Territory and Northern Territory versus non decriminalising states.	Decriminalisation of cannabis possession, use and cultivation between 1988 and 1998.	14–25 years, Australian National Drug Strategy Household Survey (NDSHS) /n=15 468.	Repeated cross-sectional surveys (1988, 1991, 1993, 1995 and 1998).	12-month use.	Ordered probit model controlled for sex, age, marital status, dependent children, ethnicity, educational level, employment, capital city residence and decriminalisation regime.	d=0.04, 95% CI −0.102 to 0.192.	R1: 9.2. R2: 10. Average: 9.6. Very low.
Williams and Bretteville-Jensen[58]	South Australia, Australian Capital Territory, Northern Territory and Western Australia versus non-decriminalising states.	Decriminalisation of cannabis possession, use and cultivation between 1987 and 2004.	20–40 year old lifetime users of cannabis participating in the Australian NDSHS /n=39 087.	Repeated cross-sectional surveys (1998, 2001, 2004, 2007 and 2010).	Age at initiation.	Difference-in-differences with discrete time hazard model controlled for sex, education, ethnicity, capital city residence and survey year.	12–17 years: d=0.57, 95% CI 0.52 to 0.63.	R1: 10. R2: 10. Average: 10. Very low.
Fuller[59]	England.	Declassification of cannabis from schedule B to schedule C drug (2004) and then back (2009).	11–15 year olds participating in a representative school survey/n=6173.	Repeated cross-sectional surveys (2001–2014).	12-month use.	Prevalence rates.	2004 versus 2009: d=−0.22, 95% CI −0.29 to −0.165 (unadjusted).	R1: 6.4. R2: 6.4. Average: 6.4. Probable.
Braakmann and Jones[60]	UK.	Declassification of cannabis from schedule B to schedule C drug (2004).	15–25 year olds participating in the Offending, Crime and Justice Survey/n=2539.	Cohort study (2003–2006).	12-month and 30-day use.	Difference-in-differences model controlled for age and calendar year.	12-month use; 15–17 years: d=−0.01, 95% CI −0.07 to 0.002; 18–25 years: d=−0.05, 95% CI −0.15 to 0.05; 30 day use: 15–17 years: −0.006, 95% CI −0.009 to 0.08; 18–20 years: −0.13, 95% CI −0.24 to −0.02.	R1: 8.6. R2: 8.0. Average: 8.3. Possible.
Miech *et al*[37]	California versus other US states.	Decriminalisation in 2010.	8th, 10th and 12th grade students participating in the MTF/n=97 238.	Repeated cross-sectional surveys (2007–2012).	12-month and 30-day use.	Generalized Estimated Equation (GEE) regression models.	12-month use: d=0.32, 95% CI 0.31 to 0.34; 30-day use: d=0.57, 95% CI 0.55 to 0.59 (unadjusted).	R1: 8.6. R2: 9.0. Average: 8.8. Possible.
Shi *et al*[63]	Cross-national study of 38 countries.	Depenalisation, decriminalisation, and partial prohibition changed since 0–5 years, 5–10 years or >10 years.	15 year olds participating in the Health Behaviour in School-Aged Children Study/n=172 894.	Repeated cross-sectional surveys (2001/2002, 2005/2006 and 2009/2010).	12-month and regular (≥40 times in lifetime) use.	Multilevel logistic random intercept regression.	12-month use: d=−0.004, 95% CI −0.02 to 0.13; regular use: d=0.17, 95% CI 0.13 to 0.20.	R1: 8.2. R2: 8.0. Average: 8.1. Possible.
Červený *et al*[62]	The Czech Republic.	Decriminalisation of cannabis possession in 2010.	15–25 years participating in drug use monitoring surveys/n=1086 in 2008 and 438 in 2012.	Repeated cross-sectional surveys (2008–2012).	Age at initiation.	Mixed proportional hazards controlled for sex, education, birth cohort and region of residence.	d=−0.26, 95% CI −0.37 to −0.15 (unadjusted).	R1: 10. R2: 10. Average: 10. Very low.

Table 2 Studies examining cannabis use levels in adolescents before and after the legalisation of cannabis use for medical purposes (1996–2018)

Study	Place of study	Type of policy change/ study period	Participant characteristics/n	Study design	Cannabis use measure (frequency/period)	Statistical methods/ covariates	Key findings/effect size	Risk of bias (/10)(rater 1 (R1); rater 2 (R2))
Khatapoush and Hallfors[29]	California (CA).	State-level medical marijuana laws (MML): Proposition 215 (1996).	16–25 year olds participating in the Robert Wood Johnson Foundation's Fighting Back initiative/n=2651.	Repeated cross-sectional surveys in 1995, 1997 and 1999.	12-month and 30-day use.	Logistic regression model.	12-month use: d=0.54, 95% CI 0.48 to 0.59; 30-month use: d=0.72, 95% CI 0.64 to 0.79 (unadjusted).	R1: 8.6. R2: 8.0. Average: 8.3. Probable.
Gorman and Charles Huber[30]	Los Angeles, San Diego, San Jose (CA) and Portland (OR).	State-level MMLs introduced before 2002.	10–18 year olds registered in the Arrestee Drug Abuse Monitoring system/on average n=255 in California and n=81 in Oregon.	Routine data collection (1995–2002).	Urine test data (≥50 ng of THC - tetrahydracannabinniol per decilitre).	Interrupted time series design.	California: 10–18 years: d=−0.42, 95% CI −0.60 to −0.24; Oregon: 10–18 years: d=−0.75, 95% CI −1.33 to −0.17 (unadjusted).	R1: 9.2. R2: 9.1. Average: 9.2. Low.
Wall *et al*[31]	Alaska, California, Colorado, Hawaii, Maine, Nevada, Oregon, Washington+Michigan, Montana, New Mexico, Rhode Island, Vermont+Arizona, Delaware and New Jersey versus other US states.	State-level MMLs introduced before 2002.	12–17 olds participating in the National Survey of Drug Use and Health (NSDUH)/n~11 813.	Repeated cross-sectional surveys (2002–2008).	30-day use.	Fixed effects model with random intercept, controlled for cannabis use 2002–2008.	2002–2003: d=0.15, 95% CI 0.07 to 0.23.	R1: 9.7. R2: 9.4. Average: 9.6. Very low.
Harper *et al*[32]	Alaska, California, Colorado, Hawaii, Maine, Nevada, Oregon, Washington+Michigan, Montana, New Mexico, Rhode Island and Vermont versus other US states.	State-level MMLs introduced before 2002.	12–17 year olds and 18–25 year olds participating in the NSDUH /n~11 813 per age group.	Repeated cross-sectional surveys (2002–2009).	30-day use.	Difference-in-differences estimates controlled for measurement error.	12–17 years: d=−1.25, 95% CI −1.29 to −1.21; 18–25 years: d=1.71, 95% CI 1.67 to 1.75.	R1: 9.4. R2: 9.5. Average: 9.5. Very low.
Anderson *et al*[33]	Alaska, Arizona, California, Colorado, Delaware, District of Columbia, Hawaii, Maine, Michigan, Montana, Nevada, New Jersey, New Mexico, Oregon, Rhode Island, Vermont and Washington versus other US states.	State-level MMLs introduced before 2011.	15–19 years olds participating in the National and State Youth Risk Behavior Surveys (YRBS) /n=786 568.	Repeated cross-sectional surveys (1993–2011).	30-day use; 30-day frequent use.	Linear regression controlled for age, sex, race, grade, state-level marijuana decriminalisation, Blood Alcohol Content (BAC) 0.08 laws, state beer tax, income per capita and unemployment.	YRBS: 30-day use: d=−0.32, 95% CI −0.33 to −0.32; 30-day frequent use d=−0.18, 95% CI −0.19 to −0.18.	R1: 8.5. R2: 8.1. Average: 8.3. Possible.
Lynne-Landsman *et al*[34]	Delaware, Michigan, Montana, Rhode Island compared pre-MML and post-MML implementation.	State-level MMLs introduced 2003–2009.	9–-12th graders participating in the YRBS /n~11 453.	Repeated cross-sectional surveys (2003–2009).	30-day use.	Difference-in-differences controlled for age, ethnicity and sex.	d=0.24, 95% CI 0.20 to 0.28.	R1: 9.2. R2: 10. Average: 9.6. Very low.
Choo *et al*[35]	Idaho versus Montana, Massachusetts versus Rhode Island, New Hampshire versus Maine, Utah versus Nevada and New York versus Vermont.	State-level MMLs.	9–12th graders participating in the YRBS/n~11 703 100.	Repeated cross-sectional surveys since 1991, 1993, 1995, 1997, 1999, 2001, 2003, 2005 and 2007.	30-day use.	Difference-in-differences controlled for state, year, age, sex, race and grade.	d=0.065, 95% CI 0.026 to 0.105.	R1: 10. R2: 9.5. Average: 9.8. Very low.
Wen *et al*[36]	District of Columbia, Michigan, Montana, New Jersey, New Mexico, Rhode Island and Vermont versus US states with no MML laws by 2010.	State-level MMLs introduced between 2004 and 2010.	12–20 year olds participating in the NSDUH/n~183 600.	Repeated cross-sectional surveys (2004–2011).	30-day use.	Fixed-effects models controlled for age, sex, race, self-reported health, cigarette use, urban residence, family poverty, state-level unemployment, mean income, median income and alcohol excise taxes.	d=−1.72, 95% CI −1.73 to −1.71.	R1: 9.6. R2: 10. Average: 9.8. Very low.
Hasin *et al*[38]	21 US states that passed MML versus non-MML US states.	State-level MMLs introduced by 2014.	8th, 10th and 12 grade (13, 15 and 17) students participating in the Monitoring the Future surveys (MTF) /n=1 098 070.	Repeated cross-sectional surveys (1991–2014).	30 day use.	Multilevel regression models controlled for sex, age, race, parental education, class size, private school, urban setting, state-level proportion of males, whites, persons with no high school education and aged 11–24 years.	d=−0.033, 95% CI −0.039 to −0.026.	R1: 10. R2: 10. Average: 10. Very low.
Schuermeyer *et al*[39]	Colorado versus 34 non-MML US states.	State-level MMLs introduced in 2009.	12–20 year olds participating in the NSDUH/n~158 600 12–17 year olds+159 200 18–25 year olds.	Repeated cross-sectional surveys (2006–2011).	≥20 times in 30-day use.	Logistic regression controlled for state, year, age, sex, race, educational level and state-by-year interaction.	12–17 years: d=0.09, 95% CI −0.04 to 0.23; 18–25 years: 0.23, 95% CI 0.16 to 0.29 (unadjusted).	R1: 9. R2: 8.2. Average: 8.6. Possible.

Continued

Table 2 Continued

Study	Place of study	Type of policy change/ study period	Participant characteristics/n	Study design	Cannabis use measure (frequency/period)	Statistical methods/ covariates	Key findings/effect size	Risk of bias (/10)(rater 1 (R1); rater 2 (R2))
Pacula *et al*[40]	Alaska, Arizona, California, Colorado, Delaware, District of Columbia, Hawaii, Maine, Maryland, Michigan, Montana, Nevada, New Jersey, New Mexico, Oregon, Rhode Island, Vermont and Washington versus US states with no MML in 2012.	State-level MMLs introduced before 2012; comparison of different legal provisions: patient registry; home cultivation; an legal dispensaries.	-<21 year olds participating in the National Longitudinal Survey of Youths 1997 (NLSY)/46 375.	Cohort study (1997–2011).	30-day use.	Difference-in-differences models controlled for population unemployment rate, age distribution, state beer tax rate, BAC 0.08 tax;	d=−0.0109, 95% CI −0.03 to 0.009.	R1: 8.2. R2: 8.6. Average: 8.4. Possible.
Keyes *et al*[41]	21 US states that passed MML versus non-MML US states.	State-level MMLs introduced by 2014.	8th, 10th and 12th grade (13, 15 and 17) students participating in the MTF /n=973 089.	Repeated cross-sectional surveys (1991–2014).	30-day use.	Time-varying multilevel regression models controlled for sex, age, race, parental education, class size, private school, urban setting, state-level proportion of males, whites, persons with no high school education and aged 11–24 years	d=−0.03, 95% CI −0.03 to −0.027.	R1: 9.6. R2: 9.5. Average: 9.6. Very low.
Maxwell and Mendelson[42]	California, Colorado and Washington versus other US States.	State-level MMLs and recreational marijuana laws.	12–25 year olds participating in the NSDUH.	Repeated cross-sectional surveys (2002–2013).	12-month use.	Comparison of prevalence rates	Impossible to calculate.	R1: 5 R2: 6.8 Average: 5.9 Probable
Stolzenberg *et al*[43]	Alaska, Arizona, California, Colorado, Delaware, Hawaii, Maine, Michigan, Montana, Nevada, New Jersey, New Mexico, Oregon, Rhode Island, Vermont and Washington versus other US states.	State-level MMLs introduced between 1998 and 2011.	12–17 olds participating in the NSDUH /n~112 500.	Repeated cross-sectional surveys (2002–2011).	30-day use.	Random effects model controlled for state-level medical cannabis possession limit, cannabis availability, % enrolled in drug class, alcohol use, prior crime conviction, % families on income assistance, % juveniles who skipped school, % families where the father resides in household, % male and % white.	d=0.060, 95% CI 0.034 to 0.087.	R1: 7.3. R2: 8.1. Average: 7.7. Possible.
Wall *et al*[44]	Arizona, Delaware, Michigan, Montana, New Jersey, New Mexico, Rhode Island and Vermont versus other US states.	State-level MMLs introduced between 2004 and 2011.	12–17 olds participating in the NSDUH /n~112 500.	Repeated cross-sectional surveys (2002–2011).	30-day use.	Fixed effects model.	d=−0.0059, 95% CI −0.030 to 0.018.	R1: 9.4. R2: 10. Average: 9.7. Very low.
Martins *et al*[45]	Arizona, Connecticut, Delaware, Illinois, Massachusetts, Michigan, New Hampshire, New Jersey, New Mexico and Rhode Island versus other US states.	State-level MMLs introduced between 2005 and 2013.	12–17 and 18–25 year olds participating in the NSDUH/ n=175 000 12–17 year olds and 175 000 18–25 year olds.	Repeated cross-sectional surveys (2004–2013).	30-day use.	Multilevel logistic regression controlled for sex, ethnicity, insurance status, household income, population density, state proportions of sex, ethnicity, youths, education, unemployment and median household income.	12–17 years: d=0.02, 95% CI −0.04 to 0.08; 18–25 years: d=0.006, 95% CI −0.035 to 0.047).	R1: 9.1. R2: 10. Average: 9.6. Very low.
Johnson *et al*[49]	Alaska, Arizona, Colorado, Delaware, Maine, Michigan, Montana, Nevada, New Jersey, New Mexico, Rhode Island and Vermont versus other US states.	State-level MMLs introduced between 1998 and 2011.	9th–12th graders (14-17) participating in the YRBS /n=715 014.	Repeated cross-sectional surveys (1991–2011).	30-day use and 30-day heavy use (≥20 times).	Fixed-effect multiple logistic regression controlled for year, state, age, sex and ethnicity.	30-day use: d=−0.042, 95% CI −0.051 to −0.032; 30-day heavy use: d=0.0001, 95% CI −0.018 to 0.0185.	R1: 9.5. R2: 9.5. Average: 9.5. Very low.
Borodovsky *et al*[53]	Alaska, Colorado, District of Columbia, Oregon and Washington versus 20 US states that did not.	Legalisation status: MML or Recreational cannabis laws (RCCL) versus no legal cannabis law.	14–18 year olds recruited online (via targeted Facebook invitations) /n=2630.	Cross-sectional survey (29 April–18 May 2016).	30-day cannabis use via smoking, vaporising or eating.	Logistic and linear regression controlled for age, gender, race, grade level, lifetime days of cannabis use and age of onset.	d=0.064, 95% CI −0.048 to 0.176.	R1: 9.5. R2: 9.1. Average: 9.3. Low.

Continued

Table 2 Continued

Study	Place of study	Type of policy change/ study period	Participant characteristics/n	Study design	Cannabis use measure (frequency/period)	Statistical methods/ covariates	Key findings/effect size	Risk of bias (/10)(rater 1 (R1); rater 2 (R2))
Mauro *et al*[14]	Arizona, Connecticut, Delaware, Illinois, Maine, Michigan, New Hampshire, New Jersey, New Mexico and Rhode Island versus 27 US states with no MML by 2013.	State-level MMLs introduced prior to 2015.	12–17 and 18–25 year olds participating in the NSDUH /n~175 000 12–17 year-olds and 175 000 18–25 year year olds.	Repeated cross-sectional surveys (2004–2013).	State-level 30-day and daily use.	Multilevel linear regression controlled for trends in marijuana use and state-level % males, % white, % aged 10–24 years, %>25 years with no high school degree, % unemployed and median household income.	30-day use: 12–17 years: d=0.041, 95% CI 0.022 to 0.059; 18–25 years: d=0.016, 95% CI 0.003 to 0.029; daily use: 12–17 years: d=−0.003, 95% CI −0.021 to 0.014; 18–25 years: d=0.064, 95% CI 0.050 to 0.078.	R1: 10. R2: 9.5. Average: 9.8. Very low.
Cerdá *et al*[10]	Arizona, California, Colorado, Connecticut, Delaware, Illinois, Maine, Maryland, Massachusetts, Michigan, Minnesota, Montana, Nevada, New Hampshire, New Jersey, New Mexico, New York, Oregon, Rhode Island, Vermont and Washington versus other US states.	State-level MMLs introduced prior to 2015; time since legalisation.	8th, 10th and 12th graders (13, 15 and 17) participating in the MTF/n=1 140 768.	Repeated cross-sectional survey (1991–2015).	30-day use.	Difference-in-differences models controlled for individual grade, age, sex, race/ethnicity, socioeconomic status, number of students per grade, public versus private school, school in metropolitan statistical area, state-level % males, % white, % aged 10–24 years and % older than 25 with no high school degree.	d=0.0176, 95% CI 0.0170 to 0.0182.	R1: 10. R2: 10. Average: 10. Very low.

appeared to be outliers (online supplementary figures 2A,B), the I^2 was reduced to 98.6% but remained too high to conduct a robust meta-analysis. This was unchanged when the analysis was restricted to cohort studies, study year (<2000 or ≥2000), a particular age group (12–17 or 18–25 years) or recent cannabis use (30 days).

Legalisation of cannabis for recreational purposes

As shown in table 3, we identified eight studies examining the impact of recreational cannabis laws, which make it legal to use and possess small amounts of cannabis, on youths. They were all conducted in the USA, where several states have introduced this form of cannabis legalisation since 2012. Four studies were based in Washington state,[46–48 52] two in Colorado,[54 55] one in Washington state and Colorado[50] and one in Oregon.[51] Only one study—based on the MTFS—was characterised by a very low risk of bias.[50] This investigation (n=253 902) reported a statistically significant increase in cannabis use among adolescents living in Washington state (3.2% increase among 8th graders and 5.0% increase among 10th graders) but not among those living in Colorado.

We also identified two studies characterised by a low risk of bias. One (n=13 335) reported a 2.0%–3.5% increase in the frequency of cannabis use among college students living in Washington state[52] and the other an increase of. 02% among middle and high school students living in Colorado (n=24 171).[54]

Meta-analysing all eight studies, we observed an I^2 of 89.8%, indicating high heterogeneity (online supplementary figures 3A,B). After excluding the study conducted by Cerdá *et al*,[50] which appeared to be an outlier, the I^2 was reduced to 45.0%. This analysis yielded an average standardised mean difference of 0.03 (95% CI −0.01 to 0.07), suggesting a possible small increase in the use of cannabis following the legalisation of recreational cannabis.

DISCUSSION

Main findings

Our systematic review of studies examining the impact of the liberalisation of cannabis legislation on patterns of use among adolescents and young people, identified 41 reports published prior to March 2018, 16 characterised by a very low risk of bias and 9 by a low risk of bias. With the exception of one study, high-quality reports examining the impact of cannabis decriminalisation (n=4) show no statistically significant change in youths' patterns of use. Similarly, the legalisation of cannabis use for medical purposes, extensively evaluated in the USA, does not appear to have an effect: six studies suggest no change in cannabis use among youths, three studies observe a decrease and four studies report an increase. However, the legalisation of cannabis for recreational purposes, examined in six studies with a very low or low risk of bias, may be associated with a small increase in levels of use among youths.

Table 3 Studies examining cannabis use levels in adolescents before and after legalisation of recreational cannabis use (2016–2018)

Study	Place of study	Type of policy change/study period	Participant characteristics/n	Study design	Cannabis use measure (frequency/period)	Statistical methods/ covariates	Key findings	Risk of bias (/10) (rater 1 (R1); rater 2 (R2))
Estoup *et al*[46]	Washington.	Legalisation in 2012.	High school students (14–17) with problematic substance use enrolled in high school in the Seattle area/n=262.	Cohort study (2010–2015).	3-month use.	Mediation model.	d=0.061, 95% CI −0.110 to 0.232 (unadjusted).	R1: 7.1. R2: 7.4. Average: 7.3. Possible.
Mason *et al*[47]	Washington versus other US states.	Legalisation in 2012.	8th graders (14) in Tacoma, Washington participating in a longitudinal study/n=238.	Cohort study (2010/2011–2012/2013).	30-day use.	Multilevel regression models controlled for substance use initiation prior to baseline.	d=0.323, 95% CI −0.177 to 0.825.	R1: 9.2. R2: 9.1. Average: 9.2. Low.
Fleming *et al*[48]	Washington versus other US states.	Legalisation in 2012.	10th (16) graders participating in the biennial Washington state school survey/n=30365.	Repeated cross-sectional surveys (2000–2014).	30-day use.	Logistic regression analyses controlled for perceived harm of marijuana, alcohol use and year.	d=0.044, 95% CI −0.019 to 0.069.	R1: 9.2. R2: 9.2. Average: 9.2. Low.
Cerdá *et al*[50]	Colorado and Washington versus other US states.	Legalisation in 2012.	13–18 years participating in the Monitoring the Future surveys (MTF)/n=253 902.	Repeated cross-sectional surveys (2010–2015).	30-day use.	Difference-in-differences.	d=1.03, 95% CI 1.00 to 1.06.	R1: 9.1. R2: 10. Average: 9.6. Very low.
Kerr *et al*[51]	Two universities in Oregon versus six in other US states.	Legalisation in 2015.	18–26 year old college undergraduates participating in the Healthy Minds Study/ n=10 924.	Repeated cross-sectional surveys (2014 and 2016).	30-day use.	Mixed-effects logistic regression controlled for cigarette use, year in college, age, sex, race, residential type, relationship status, sexual orientation, international student status, depression, anxiety, adjustment, institution size and survey period.	d=0.0139, 95% CI 0.048 to 0.075.	R1: 9.5. R2: 8.5. Average: 9. Low.
Miller *et al*[52]	Washington.	Legalisation in 2012; opening of licenced retail stores for marijuana in 2014.	College students participating in the National College Health Assessment (WSU NCHA)/ n=13 335.	Repeated cross-sectional surveys (2005, 2006, 2008, 2010, 2012, 2014 and 2015).	30-day use.	Logistic regression controlled for age, sex, race, year in school and estimated secular increase in cannabis use.	Postmedical marijuana laws (post-MML) (2014): d=0.04, 95% CI 0.002 to 0.083; postrecreational marijuana laws (2015): d=0.082, 95% CI 0.034 to 0.130.	R1: 9.5. R2: 8.5. Average: 9. Low.
Harpin *et al*[64]	Colorado.	Legalisation in 2012.	6–12th grade (11–17) students (Healthy Kids Colorado Survey)/ n=24 171.	Repeated cross-sectional survey (2013 and 2014).	30-day use.	Comparison of prevalence rates.	d=0.006, 95% CI −0.026 to 0.038 (unadjusted).	R1: 9.4. R2: 9.4. Low.
Jones *et al*[55]	Colorado.	Legalisation in 2012.	College students(22–24 years) n=1413.	Repeated cross-sectional survey (October 2013, March 2014, October 2014 and March 2015).	Lifetime.	Comparison of prevalence rates.	d=−0.215, 95% CI −0.385 to −0.039 (unadjusted).	R1: 4.4. R2: 5.0. Average: 4.7. High.

Overall, policies regarding cannabis use and possession seem to have little effect on actual patterns of use among young people, with the possible exception of the legalisation of recreational use. To date, evidence regarding the impact of the legalisation of recreational cannabis comes from the USA, where prevalence levels of substance use are high and laws liberalising cannabis use tend to be market oriented. Additional data from other settings (eg, Uruguay and Canada) will help gain a better understanding of relations between cannabis policy and patterns of use in the population.

Limitations and strengths

Our systematic review and meta-analysis has limitations that need to be acknowledged. First, the specific provisions of laws and policies regulating cannabis and that can influence actual access to the substance[2] vary across settings. For example, decriminalisation can imply different limits on the amount of cannabis that leads to a fine; for example, the possession of 15 g of herb or 5 g of resin in the Czech Republic is fined approximately 550 euros[62]; in the Australian Capital Territory (Canberra region), the possession of up to 25 g is fined approximately 100 euros, while in Western Australia (Perth region), the possession of less than 10 g is tolerated but higher quantities can result in a conviction.[64] Similarly, laws allowing the use and possession of cannabis for medical purposes, currently in place in approximately 20 countries (eg, Australia, Belgium, Spain, Canada and some US states) take different forms. For instance, only the Netherlands and some US states make it possible for individuals to purchase or grow cannabis that can be smoked; in other settings, individuals can purchase specific medicines derived from cannabinoids (eg, the UK). The legal age at which individuals are authorised to possess cannabis (18 or 21 years) varies across settings, with possibly differential effects on levels of use among young adults. Finally, the price of cannabis, which influences levels of use among young people,[57 65] varies from place to place and over time. Clearly, differences in specific policy provisions, which have an impact on cannabis availability, make it difficult to compare different settings. Nevertheless, at the time of its implementation or even before if there is wide media coverage, policy change in and of itself can influence the perceptions of cannabis, which in turn shape levels of use,[41] justifying the conduct of this systematic review. Second, the duration of follow-up varies across studies, in part because changes in cannabis policy occurred in different periods and places. This is especially a concern for reports evaluating the impact of recreational cannabis laws: policy changes introduced decades ago (eg, the Netherlands) were not fully evaluated, while follow-up is limited for more recent policy modifications (eg, the USA and Uruguay). It is unclear whether the introduction of policies that liberalise cannabis use and possession is most likely to influence patterns of use in the short term or in the long term; in the present report, we considered that a follow-up period of at least 1 year following actual policy implementation was necessary to test a possible effect. Third, among studies examining the consequences of the legalisation of cannabis for recreational purposes, we only identified one study characterised by a very low risk of bias and five studies by a low risk of bias, and the findings we report will need to be confirmed. Our attempt to meta-analyse the results of different studies included in this review proved inconclusive, with the exception of legalisation of cannabis for recreational purposes: this calls for additional, methodologically robust, studies in this area. Fourth, although changes in cannabis policies have occurred in various settings, most studies included in this report were conducted in the USA, where most research in this area has been conducted. It is difficult to assess the extent to which the findings observed in the USA will generalise to other countries, and it will be important to update knowledge in this area once data from other places (eg, Uruguay and Canada) become available.

Despite these limitations, our study has several strengths: (A) the evaluation of studies published in different disciplines (public health, epidemiology, economics and social policy) through multiple databases; (B) the combination of data from different settings (USA, Australia and Europe); (C) special attention to the risk of bias, examined using a framework especially developed for observational studies. Moreover, our systematic review takes into consideration different forms of liberalisation of cannabis policies (decriminalisation, legalisation for medical purposes and for recreational purposes), attempting to tackle this complex issue in a thorough way.

Methodological issues

The studies included in this systematic review relied on several different datasets and applied quite varied methods (logistic regression,[45] difference-in-differences[35] and fixed-effects models[36]) to isolate the effects of policy change on patterns of cannabis use independently of individual and contextual characteristics; such triangulation of different methods is considered especially reliable when, as in this case, it yields consistent results.[66] Importantly, because cannabis policy changes most often occur in settings where public support and levels of use are high, it is essential to take into account levels of cannabis use prior to policy change, as was the case in all reports we considered to present a very low or low risk of bias. Finally, it is important to note that we evaluated relative changes in cannabis use postpolicy versus prepolicy change. Levels of cannabis use vary widely across settings and in some places may have been so high prior to policy change that additional increases are unlikely (this may be the case of Colorado where over 25% of 12th graders use cannabis on a monthly basis).[50]

Most studies included in our systematic review were cross-sectional, because reports based on longitudinal data are less numerous and were not always of sufficiently high quality. While repeated cross-sectional studies are well suited to examine long-term changes in patterns of cannabis use in relation to changes in the legal context, additional evidence from longitudinal data following young people would make it possible to take into account

individual characteristics and further strengthen the inference that can be drawn regarding the impact of cannabis policy change.

Implications

Summarising the available evidence, we found that, contrary to what has been observed in adults,[36 57 67] cannabis decriminalisation and legalisation for medical purposes are probably not related to significant changes in patterns of use among adolescents and young people. This was also recently reported by a systematic review and meta-analysis that focused on medical cannabis laws and patterns of use in the preceding 30 days among adolescents.[68] However, the legalisation of cannabis use for recreational purposes may lead to higher levels of use in this age group and a younger age at initiation. Several hypotheses have been proposed to explain this multifactorial phenomenon: (A) changes in the reporting of cannabis use; (B) a decrease in perceived harmfulness[41]; (C) an increase in cannabis availability and access; and (D) a decrease in price (in legal outlets or on the black market).[69] While the liberalisation of cannabis policy can have both collective and individual benefits (eg, decrease in costs of law enforcement, increase in quality control and reduction in individuals' difficulties with the legal system), these data suggest the possibility of small negative public health implications. Adolescents and young adults are especially vulnerable to the consequences of cannabis use, in terms of both biological and social development[70 71]; therefore, policies that involve the legalisation of recreational use of cannabis need to be accompanied by prevention efforts targeted towards young people. The most effective prevention programmes aim to improve school climate and strengthen youths' psychosocial skills such as self-esteem and conflict resolution.[72 73]

CONCLUSION

In recent decades, cannabis policies have been liberalised in different ways (decriminalisation, legalisation of use for medical or recreational purposes) and in various settings. Our systematic review and meta-analysis of 41 research articles published across disciplines (epidemiology, economics and social policy) and using a variety of datasets and statistical methods shows that cannabis decriminalisation or legalisation of use for medical purposes do not result in higher levels of use among youths. Legalisation of use for recreational purposes appears to possibly result in a small increase. It will be important to reassess whether this tendency persists over time, varies across subgroups of youths (male vs female, urban vs rural, socioeconomically disadvantaged vs favoured) and is comparable across settings, particularly as additional countries introduce changes in cannabis policy (eg, Canada). Repeated cross-sectional as well as longitudinal studies will be necessary to thoroughly evaluate adolescents' levels of cannabis use following changes in policy.

Contributors MM had the original idea for the study and proposed the study design. FH and MADS conducted the literature search, screened and selected the studies initially identified. MM, CB, MADS and MM-K read and evaluated the quality of the studies included. AN and FEK conducted the meta-analysis. MM wrote the initial manuscript and serves as guarantor. All authors contributed to interpreting the study findings and to the final manuscript.

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