Assessing the public health impacts of legalizing recreational cannabis use: the US experience

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The sale of cannabis for adult recreational use has been made legal in nine US states since 2012, and nationally in Uruguay in 2013 and Canada in 2018. We review US research on the effects of legalization on cannabis use among adults and adolescents and on cannabis-related harms; the impact of legalizing adult recreational use on cannabis price, availability, potency and use; and regulatory policies that may increase or limit adverse effects of legalization. The legalization of recreational cannabis use in the US has substantially reduced the price of cannabis, increased its potency, and made cannabis more available to adult users. It appears to have increased the frequency of cannabis use among adults, but not so far among youth. It has also increased emergency department attendances and hospitalizations for some cannabis-related harms. The relatively modest effects on cannabis use to date probably reflect restrictions on the number and locations of retail cannabis outlets and the constraints on commercialization under a continued federal prohibition of cannabis. Future evaluations of legalization should monitor: cannabis sales volumes, prices and content of tetrahydrocannabinol; prevalence and frequency of cannabis use among adolescents and adults in household and high school surveys; car crash fatalities and injuries involving drivers who are cannabis-impaired; emergency department presentations related to cannabis; the demand for treatment of cannabis use disorders; and the prevalence of regular cannabis use among vulnerable young people in mental health services, schools and the criminal justice system. Governments that propose to legalize and regulate cannabis use need to fund research to monitor the impacts of these policy changes on public health, and take advantage of this research to develop ways of regulating cannabis use that minimize adverse effects on public health.

Key words: Cannabis, legalization, recreational use, public health impacts, cannabis potency, cannabis-related harms, emergency department attendances, vulnerable young people

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Cannabis is globally the most widely used illicit drug under international control. In 2017 it was estimated to be used by 188 million adults (range 164-219 million) worldwide or 3.8% of the global adult population[1]. Cannabis use is more common in North America and high-income countries in Europe and Oceania[2]. Its use has increased in some low- and middle-income countries, but remains low in Asia[1].

The inclusion of cannabis in the same schedules of the international drug control treaties as heroin, cocaine and amphetamines has been controversial, and public campaigns to legalize its use have been ongoing since the late 1960s[3]. The route to legalization of adult use in the US began with citizen-initiated referenda that legalized the medical use of cannabis, initially for serious illnesses like cancer, but progressively under liberal regulations that allowed the supply of cannabis by retail commercial cannabis "dispensaries". These changes helped to reduce public opposition to the legalization of adult cannabis use, which was first achieved by the passage of referenda in two states with some of the most liberal medical cannabis laws, Colorado and Washington State, in 2012[4].

Combinations of arguments attracted public support for recreational cannabis legalization in the US, as indicated by citizen-initiated referenda[5]. The first is that cannabis use is common among young adults and causes less harm than alcohol, tobacco and opioids[6,7]. The second is that making cannabis use a criminal offence causes more harm than cannabis use itself, because some users are arrested and receive criminal records. The third is that these criminal laws disproportionately affect cannabis users in minority populations, such as African Americans and Latinos. The fourth is that legalization of adult use is a better social policy than criminalization because: a) it eliminates the illicit market; b) it enables cannabis use to be regulated to minimize adolescent access and protect adult cannabis consumers – e.g., by controlling the tetrahydrocannabinol (THC) content of cannabis products and reducing levels of contaminants – such as fungi, heavy metals and pesticides – found in illicitly produced cannabis; c) it reduces the costs of policing the prohibition of cannabis use (freeing police resources to address more serious crimes); and d) it enables governments to raise revenue by taxing the sale of cannabis products[5].

In principle, adult cannabis use could be legalized in a range of different ways[8]. Individuals could be allowed to grow cannabis for their own use and gift it to others. They could be allowed to form cannabis growers' clubs that produce cannabis solely for their members' use. The government could create a monopoly in cannabis production and sales in order to minimize the promotion of cannabis use, as some US states and Canadian provinces have done with alcohol. The government could license non-profit cooperatives or charitable cooperatives that produce and sell cannabis without making a profit. Finally, governments could allow the commercialization of cannabis production and sale under a for-profit model like that used for alcohol[8].

Since 2012, eleven US states and the nation states Canada and Uruguay have passed legislation that has made it legal

for adults to produce, process and use cannabis. Nine US states, Uruguay and Canada now permit legal retail cannabis sales as well. In Washington DC and Vermont, it is legal for adults to grow cannabis for their personal use and to give it to friends, but it remains illegal to sell it[8-10].

The creation of a legal cannabis market is more radical than the policy changes during the 1970s, which removed criminal penalties or imprisonment for personal use and possession, but left the supply of cannabis to the illicit market. Legalization permits the establishment of a legal cannabis industry that has an interest in promoting cannabis use and, unlike policies that legalize medical cannabis use, it allows adults to use cannabis for any purpose.

Most US states that have legalized retail cannabis sales have followed Colorado and Washington State[1] in using the same regulatory approach as for alcohol, i.e. licensing companies to produce and sell cannabis for a profit[11,12]. States differ in whether they separately license growers, processers, suppliers and retail sellers or whether they allow licensees to perform all of these roles ("vertical integration")[13,14].

All states have set the same minimum legal purchase age for cannabis as for alcohol, i.e. 21 years. Many have limited the quantity of cannabis that an adult can legally carry to 28.5 g[15,16]. In most states, cannabis products are taxed on their sale price[17], but tax rates vary between states[1]. Drug-impaired driving is an offence in all states that have legalized cannabis (and in many US states that have not), but states differ in how they have enforced this law[13].

In 2013, Uruguay became the first nation to legalize adult cannabis use. It did so by allowing adults to use cannabis if they registered with the state and used one of three ways to obtain cannabis[18]: they could grow their own cannabis, join a cannabis growers' club that would produce enough cannabis for its members, or purchase cannabis (produced under government licence) from pharmacies[19,20]. The policy was introduced in phases. In the first, registered cannabis users were allowed to grow their own cannabis. In the second, cannabis growers' clubs were licensed. In the third, a small number of pharmacies were licensed to supply cannabis to registered users[1].

The Uruguayan model is still in the early stage of implementation. So, it is difficult to assess whether it has achieved its goals. Some have argued that the model is too restrictive to undermine the illicit cannabis market[20,21]. So far only 6,965 persons have registered to grow their own cannabis and there are 115 cannabis clubs with 3,406 registered members. Only 16 pharmacies (from a total of 1,200) supply cannabis, and 34,696 persons[1] have registered to purchase cannabis from pharmacies[22]. The total of 45,067 registered cannabis users comprise just under half the estimated number of cannabis users in Uruguay. We do not yet know what proportion of registered and unregistered cannabis users still purchase cannabis from the illicit market.

In October 2018, Canada became the second nation to legalize the sale of cannabis to adults[23,24]. The goals of legalization were to eliminate the illicit cannabis market and regulate the production and sale of cannabis to protect public health and minimize youth uptake[25]. The federal government licenses and regulates cannabis producers; advertising of cannabis is not permitted; and cannabis products must be sold in plain packaging with health warnings. The minimum legal purchase age is 18 (unless a provincial government sets a higher one), and it is an offence to drive while impaired by cannabis.

Provincial governments in Canada regulate wholesale and retail cannabis sales in the same way as they regulate alcohol[26]. Provinces with an alcohol retail monopoly can use the same regulatory approach for cannabis, and retail cannabis sales are allowed in provinces that licence for-profit retailers of alcohol. The Canadian federal government collects taxes on cannabis and shares these revenues with provincial governments. The sale of edible cannabis products and cannabis extracts began in October 2019, with taxes based on their THC content.

As is the case with Uruguay, Canadian policy is still at an early stage of implementation. So, it is too early to evaluate its impact. The remainder of this paper accordingly focuses on the impacts to date of the legalization of recreational cannabis use in the US.

HOW HAS RECREATIONAL LEGALIZATION AFFECTED CANNABIS MARKETS IN THE US?

The legalization of recreational cannabis use in the US has had a number of effects. First, it has been followed by a substantial decrease of the retail price of cannabis[17]. Second, it has allowed adults to obtain a regular supply of cannabis without risk of criminal penalty. Third, it has produced a major diversification of the cannabis products for sale[27]. In addition to cannabis flower, cannabis retail outlets also sell high-potency cannabis extracts (wax, shatter), edible cannabis (e.g., gummy bears, candy and chocolates), and cannabis infused beverages[17]. These products presumably meet the needs of a broader range of adult consumers than the illicit market primarily catered to, namely, daily or near daily cannabis smokers[17]. The increased availability and marketing of cannabis, and more publicly visible cannabis use by adults, may make cannabis use more socially acceptable and enable more adults to use cannabis for a longer period of their lives than has been the case under prohibition.

Cannabis prices have fallen steeply in the US states that have legalized its recreational use[17,28,29]. Prices no longer need to include a premium to compensate illicit producers and sellers for the risks of being arrested or imprisoned or subjected to violence by other illicit market participants. Legal cannabis production is no longer small scale and clandestine, allowing growers to increase the scale of production, reduce their costs, and pass these on to consumers in the form of lower prices. If states allow licensees to grow, process and sell cannabis wholesale and retail, as in Colorado, then cannabis production can become even more efficient[29].

Most US legalization states have imposed taxes on the retail price of cannabis products[29]. This method of taxing cannabis has had two consequences: state cannabis tax revenue has declined as retail prices have fallen; and cannabis producers and retailers have had an incentive to increase the THC content per gram of product to reduce prices and increase profits[29]. Taxes may have contributed to

the increased sale of cannabis extracts with a THC content of 70% or more (21% of all sales in some states). The increase in cannabis potency presumably satisfies the preferences of daily cannabis users (who account for most sales). A cap on THC content or a minimum unit price or tax based on THC content would reduce this incentive[8], but so far no US state has adopted any of these policies.

Cannabis prices may decline further. Local regulations have restricted up to now the number and location of retail outlets in some states to the larger cities[30]. Cannabis prices are likely to fall much further if legalization of adult use becomes US national policy, because this would allow cannabis production on a larger scale, potentially permit the establishment of inter-state commerce, facilitate the increase in multi-state operations, allow the development of US-based multinational companies via mergers and acquisitions, and attract large scale investment from the alcohol, tobacco and finance industries.

Historical experiences with the regulation of alcohol and tobacco[31,32] suggest that, in the short term, increasing access to more potent cannabis products at a lower price is likely to increase the frequency of cannabis use among current users. In the longer term, a profit-seeking legal cannabis industry is likely to attempt to increase the number of cannabis users, and the regularity of their use, in order to maximize its profits. This will involve a combination of promotional activities (e.g., media advertising, price discounts, and discounts for regular purchasers) that aim to increase the number of daily cannabis users and the proportion of adults who use cannabis. There is considerable uncertainty about how much and how soon such promotional activities will succeed. Experience with alcohol suggests, however, that the larger the proportion of the population that uses cannabis, and the more often they do so, the larger will be any adverse public health impacts of cannabis legalization[31].

In the remainder of this paper, we review evidence on the public health effects to date of the legalization of recreational cannabis use in the US. As an early adopter, the US is likely to influence the policies adopted in other countries that decide to legalize cannabis use. Moreover, the US collects survey data on patterns of cannabis use in the population and health data on cannabis- and alcohol-related harms. As Canada and Uruguay proceed to implement cannabis legalization, similar high quality survey[33,34] and other data will be collected to assess the public health impacts of legalization in these countries.

WHAT ADVERSE HEALTH EFFECTS MAY INCREASE AFTER CANNABIS LEGALIZATION?

We summarize here the adverse effects that may increase if harmful patterns of cannabis use, especially daily use, increase as a result of legalization. The content is based on reviews of the evidence on the adverse health effects of cannabis[35-37] and analyses of health outcomes that should be monitored after cannabis legalization [38-40].

Acute effects

Car accidents may increase if more cannabis users drive, or drive more often, while impaired, or if cannabis users who drive use more potent cannabis products[36,37]. More cannabis users may present to emergency departments with acute psychological distress and psychotic symptoms if they use more potent cannabis products such as extracts[36]. Adverse effects of cannabis on fetal development[36,37] may increase if more women use cannabis during pregnancy, as appears to be the case in the US[41].

Relationships between cannabis use and the use of alcohol, tobacco and opioids will substantially affect the public health impacts of cannabis legalization[38,40,42]. The public health burdens of these drugs could be reduced if cannabis becomes a substitute, while their impact could be amplified if there is more concurrent use of cannabis and these drugs[38,40].

Chronic effects

More frequent use of potent cannabis may increase the prevalence of cannabis dependence, i.e. more cannabis users will experience impaired control over their cannabis use despite such use harming them[43]. The 9% risk of dependence among lifetime users in the US in the early 1990s may increase in those who use more potent cannabis products[44].

Daily cannabis users have impaired cognitive performance that appears to be reversed by abstinence[45]. Adolescents and young adults who are regularly intoxicated during their schooling have poorer educational attainment[46]. Cannabis-related cognitive impairment may also occur in older adults who regularly use cannabis for recreational purposes[47].

Daily cannabis use is associated with an increased risk of psychotic symptoms or a diagnosis of a schizophreniform psychosis in prospective epidemiological studies[48,49]. These risks are higher in those who begin cannabis use in adolescence, those who use it more often and for longer[48], and those who use strains with high THC and/or low cannabidiol[50]. Psychotic symptoms occur two years earlier on average in regular cannabis users[51], and persons with a psychosis who continue to use cannabis have more frequent episodes and longer periods of hospitalization for their illnesses[52]. In major European cities, an association has been reported between average cannabis potency and the incidence of psychosis[53].

Heavy cannabis users can develop a hyperemesis syndrome[54], with severe abdominal pain and cyclical vomiting. The syndrome is most often reported by daily cannabis users in the absence of any other medical cause[55]. It is relieved by hot bathing[56], resolves when users abstain from using cannabis, and may recur if they restart cannabis[54]. A small number of deaths have been attributed to complications of this syndrome[57].

Case series and a case-control study[58] suggest that heavy cannabis smoking may increase cardiovascular disease risk in young heavy cannabis smokers[59-61]. Middle-aged men who have had a myocardial infarction may experience angina if they smoke cannabis[62], and are at increased risk of a recurrence if they are cannabis users[63-65].

Cannabis-only smokers report more

cough, sputum and wheezing than persons who do not smoke cannabis[66-71], and these symptoms remit if they quit[72]. However, cannabis smokers do not appear to be at higher risk of chronic obstructive pulmonary disease[72,73].

Systematic reviews have not found an association between cannabis use and head or neck cancer[74], or lung cancer[75]. By contrast, a meta-analysis of three studies[76] found a small increase in risk of testicular cancer among high-frequency cannabis users and in those who had used cannabis for ten or more years.

HEALTH EFFECTS OF LEGALIZING RECREATIONAL CANNABIS USE IN THE US

State level legalization of recreational cannabis use for adults was only implemented about five years ago in Washington State and Colorado, the US jurisdictions with the longest experience of a legal regime to date. This is probably too short a period to judge the full effects of legalization. It has taken time to produce dependable supplies of cannabis within states that have legalized, and there are a limited number of retail outlets available in a relatively small number of locations in these states[1]. For these reasons, evaluations of the first five or so years after legalization may provide a poor indication of the impacts of cannabis use on public health when the industry develops over a decade or more[42,77].

Effects on cannabis use

If experience with alcohol and tobacco is a reasonable guide, we would expect declines in cannabis prices to be followed by increases in the frequency of use among existing users[31,32,78]. There is some evidence of increased frequency of use in response to the relatively small declines in cannabis prices that occurred under prohibition[79]. It is more difficult to estimate how much cannabis use may increase when cannabis prices fall by 30-50%[80].

Household survey data suggest that lower cannabis prices have increased the frequency of use among adult cannabis users in US states that have legalized recreational cannabis[78,81,82]. Surveys in Colorado and Washington State have found mixed evidence on the impacts of cannabis legalization on adolescent cannabis use. There was an increase in cannabis use among students after legalization in Washington State, but a decrease among adolescents in Colorado[83,84]. No changes in cannabis use were reported among youth in two surveys in Washington State conducted the year before and the year after legalization of recreational use was implemented[84]. Darnell and Bitney[85] did not find changes in youth cannabis use in Washington State between 2002 and 2016. Anderson et al[86] failed to find an increase in youth cannabis use in the Youth Risk Behavior Surveys in the four years before and the three years after the legalization of recreational use. Dilley et al[87] reported very similar results in analyses of Youth Risk Behaviour Surveys in Washington State.

Cerdá et al[81] recently compared trends in regular past 30 day cannabis use and cannabis use disorders among adolescents and young adults in US states that have and have not legalized recreational cannabis use, using data from the US drug household survey, the National Survey on Drug Use and Health. They found suggestive evidence of a small increase in these outcomes among 12-17 year olds, but did not find any similar effects among those aged 18-25 years. They were cautious in interpreting the former, because they estimated that the small increases could be due to unmeasured confounders. This was a less plausible explanation for similar increases observed in regular cannabis use and cannabis use disorders among adults 26 years and older[81].

Effects on cannabis-related hospitalizations

Cannabis-related hospitalizations have increased in Colorado after recreational cannabis use was legalized. These increases have been in addition to earlier increases that occurred after the legalization of medical cannabis use[88]. After cannabis legalization in Colorado there have also been increases in hospitalizations for cannabis abuse and dependence[89], motor vehicle accidents and injuries related to cannabis abuse[90], and head injuries attributed to an increase in falls[91].

An increase in emergency department presentations for hyperemesis in Aurora, Colorado was reported after medical cannabis use was legalized in 2000, and a further increase after recreational use legalization[92]. A 46% increase in the incidence of cyclic vomiting was reported between 2010 and 2014 in the Colorado State Inpatient Database[93].

An increase in cannabis-related emergency department presentations has been reported after legalization in Boulder, Colorado for childhood poisonings, psychological distress in adults, severe vomiting, and severe burns in users who had attempted to extract THC from cannabis oils using butane[94].

Calcaterra et al[95] analyzed trends in cannabis- and alcohol-related presentations to a hospital network in Colorado that provided emergency medical care to low-income patients in two periods: January 2009 to December 2013 and January 2014 to December 2015. The rate of cannabis-related presentations increased steeply in the latter period, while presentations involving alcohol were unchanged. Cannabis-related presentations were more likely to involve younger adults and more likely to lead to hospitalization, especially for psychiatric care.

In Colorado, emergency department presentations for mental illness with a cannabis-related code increased five times faster than mental illness presentations without such a code between 2012 and 2014[88]. The largest increases were for persons who received diagnoses of schizophrenia and other psychotic disorders, suicide and intentional self-harm, and mood disorders[96].

A review of pediatric cases from 1975 to 2015 found more unintentional cannabis ingestion by children in US states that had legalized medical and recreational cannabis use[97]. This increase prompted limits on package and serving sizes of edible cannabis products in 2017[98]. Despite these changes, pediatric hospital visits and calls to poison centres for cannabis

ingestion increased after 2017. Similar increases in accidental poisoning among children and adolescents were reported in Massachusetts before and after the legalization of medical cannabis use, despite the use of child-proof packaging and warning labels[99].

Effects on road crashes

Studies of the effects of cannabis legalization on traffic accidents have produced mixed findings.

Chung et al[100] reported an increase in the rate of patients admitted to Colorado hospitals for traumatic injury who were cannabis-positive between 2012 and 2015, in the absence of any corresponding increase in neighbouring states that had not legalized cannabis.

However, Aydelotte et al[101] did not find greater changes in traffic fatality rates in Washington State and Colorado using Fatality Analysis Reporting System (FARS) data than in neighbouring states that had not legalized cannabis. Sevigny[102] analyzed FARS data (1993-2014) using data imputation to address the large amount of missing data, and did not find an impact of legalization on cannabis-positive driving among people involved in a fatal crash. Lane and Hall[103] found a short-term increase in traffic fatalities in both US states that had legalized the commercial sale of cannabis (i.e., Colorado, Washington State and Oregon) and their neighbouring jurisdictions.

Treatment seeking for cannabis use disorders

Darnell and Bitney[85] compared trends in treatment seeking for cannabis use disorders in the Treatment Episode Data Set in Washington State in the first two years after legalization with trends in a synthetic cohort comprising a weighted sample of other US states that had not legalized cannabis. Treatment demand declined in Washington State after legalization, but at the same rate as it declined in states that had not legalized cannabis.

MONITORING THE FUTURE PUBLIC HEALTH IMPACT OF CANNABIS LEGALIZATION

There are a number of reasons why the effects of cannabis legalization to date may underestimate its full impacts on public health in the longer term.

First, the commercialization of the cannabis industry is incomplete in the US. While cannabis remains prohibited under US federal law, there are also prohibitions on inter-state commerce in cannabis and investment by the alcohol, tobacco and finance industries. It is difficult for cannabis businesses to use banks or to advertise cannabis, because it remains an illegal commodity. National cannabis legalization would remove these constraints and allow the full commercialization of the cannabis industry under constitutional protections including the "commercial freedom of speech".

Second, it is too soon to evaluate the effects of cannabis legalization in Canada and Uruguay. Both countries are still implementing their models, so it will take time for legalization to become fully operational.

Third, even after legalization is fully implemented, one would expect a delay between any increases in cannabis use and the detection of increased problems related to regular cannabis use in the health care system. The following section discusses indicators that should be monitored to evaluate the longer-term public health impacts of cannabis legalization.

Potential indicators of future cannabis-related harm

Studies of the public health impacts of legalization should monitor trends in acute harms that are likely to increase if more adults use more potent cannabis products more often. These include: car crash fatalities and injuries involving cannabis-impaired drivers; emergency department attendances for myocardial infarctions, acute coronary syndromes and strokes in young adults[58,104-106], and cyclic vomiting in young adults.

Treatment seeking for cannabis dependence should also be monitored. It is uncertain how legalization may affect it. One would expect a decline in treatment seeking among adult cannabis users who will no longer be legally coerced into treatment as an alternative to imprisonment. Adolescents with cannabis use problems may still be arrested[107] and coerced into treatment, and their numbers may increase if courts use treatment as an alternative to their criminal prosecution if they are caught using cannabis.

Legalization may also reduce treatment seeking among persons with cannabis problems if increased access to legal and cheap cannabis products reduces the economic costs of cannabis use and social pressure from families and friends to stop using cannabis. On the other hand, legalization of adult use may reduce the stigma attached to problem cannabis use and thereby encourage earlier treatment seeking, e.g. if education campaigns increase public recognition of cannabis use disorders and encourage users to seek treatment.

The US national treatment data[108] will provide useful information on these trends. These data could be expanded to include information from new treatment entrants on: reasons for seeking treatment; the type and amounts of cannabis used; usual routes of administration; and where they obtained their cannabis (to assess how many problem users are still using the illicit market).

A major research priority should be to improve assessments of the role that cannabis-impaired driving plays in fatal motor vehicle accidents. This research should assess the degree to which cannabis is a substitute for alcohol among young men, and the extent to which it reduces other types of alcohol-related harm, such as suicides and assaults.

It will be important to monitor any effects that cannabis legalization has on tobacco smoking and alcohol use among adolescents and young adults. With the decline in youth tobacco use, suggestive evidence has emerged of a "reverse gateway effect", in which initiation of cannabis smoking has increased tobacco smoking among young adults[109].

The social distributional effects of can-

nabis legalization should also be examined. One major motivation for cannabis legalization has been to eliminate the unequal enforcement of criminal penalties against minority cannabis users. Legalization has reduced arrests, but it is too early to assess its impact on rates of incarceration and minority differentials in imprisonment. It will also be important to see if minorities are over-represented among problem cannabis users who seek treatment[110].

Research should also monitor any adverse health effects that cannabis legalization has on cannabis users over the age of 50. US surveys report an increase in use among this age group since legalization[111,112], probably for a combination of medical and quasi-medical reasons (e.g., to assist with sleep, control pain, stimulate appetite). Older users may be at higher risk of some adverse health effects, such as car crashes, cardiovascular disease and cognitive impairment.

We need more rigorous evaluations of the public health impacts of cannabis legalization[42]. Comparisons of differences between states in time series data on various causes of hospitalization and death are of limited value because they are not able to test alternative explanations of state level differences[77]. We also need large prospective studies of the effects of these policy changes on the use of cannabis and other drugs and their impact on health outcomes in individuals[42].

CONCLUSIONS

The legalization of recreational cannabis use in Canada, Uruguay and an increasing number of states in the US is a large scale policy experiment whose effects may not be known for a decade or more. So far legalization has not produced large increases in cannabis use among youth in the US. As expected, it has increased regular cannabis use among adult users. It has also increased acute cannabis-related presentations to emergency departments in adults and children for physical and mental health problems related to cannabis use (e.g., psychological distress, vomiting syndromes, and accidental poisonings in children). Studies of the effects of the legalization on motor vehicle crashes are inconsistent. There are limited data on the impacts on treatment seeking for cannabis use disorders.

It would be unwise to assume that the modest effects of cannabis legalization observed to date will predict its longer-term effects. The legalization of cannabis markets has already substantially reduced the price of cannabis and increased its potency, and prices are likely to fall further if legalization becomes national policy in the US. Legalization on the limited scale to date has increased regular cannabis use among adults and it may have increased cannabis use disorders among adult users, although the evidence on this issue is insufficient. In the longer term, experience with alcohol suggests that more liberal regulation that provides legal access to cheaper, more potent cannabis products will increase the number of regular users and probably the number of new cannabis users. There is considerable uncertainty about by how many and how soon this may occur.

Future evaluations of the public health impacts of cannabis legalization should assess its effects on: attitudes towards cannabis use in young people; the frequency of cannabis use in high-risk youth and young adults (e.g., those who seek help for mental health problems and those in the criminal justice system); cannabis-related car crashes and emergency department attendances for cannabis-related problems; treatment seeking for cannabis use disorders and its outcomes; and persons seeking treatment for mental disorders.

Research should also assess how legalization affects the use and harms of alcohol and tobacco and other drug use (e.g., opioids) among youth and young and older adults. In the longer term we need to assess the effects of legalization on the duration of cannabis use in adulthood, because it is likely that legalization will extend the duration of cannabis use beyond the late 20s, the age at which most users desisted under prohibition[113]. There is some suggestive evidence that the duration of cannabis use has already increased among recent birth cohorts[114].

These evaluations should inform the design of policies to reduce cannabis-related harm after legalization. These may include: tighter regulation of youth access to cannabis; using taxes to discourage heavy cannabis use (e.g., by setting minimum prices for cannabis products, imposing potency caps, and basing cannabis taxes on THC content[115]); consumer-tested health warnings about the risks of cannabis use, especially daily cannabis use, such as cognitive impairment and cannabis dependence; and research to develop more effective ways of discouraging adolescents from starting cannabis use[116].

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