

REVIEW

Impact of the legalisation of recreational cannabis use

Impacto de la legalización del consumo recreativo del cannabis

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Abstract

In recent years, there have been important legislative changes in many countries regarding the use of cannabis for medicinal and/or recreational purposes, which have facilitated access to it. Uruguay, Canada and some of the US states are the only jurisdictions that have legalised recreational consumption, applying different legislative models. The aim of this review is to analyse the effects that the legalisation of recreational cannabis has had on its use and its consequences. In general, the evidence accumulated to date indicates that the legalisation of cannabis has been associated with a decrease in the price of the substance, higher concentration of THC (potency), greater diversity of presentations for consumption, lower risk perception and an increase in consumption in adults and moderately in adolescents (even though it is illegal for them to consume), as well as an increase in the adverse consequences derived from cannabis consumption on public health. There has been a decrease in drug-related arrests, but the illegal market continues to be frequently used. No increase in the demand for treatment due to cannabis consumption has been detected. Therefore, these legislative changes have so far failed to achieve their main objectives, which were to suppress the illegal market and protect the most vulnerable groups, while on the contrary, they seem to imply an increase in some of the negative aspects associated with cannabis consumption. However, taking into account that most of these legislative changes have entered into force relatively recently, a longer follow-up period is required to be able to draw definitive conclusions.

Keywords: cannabis, legalisation, recreational use, consequences of consumption, public health

Resumen

En los últimos años se han producido importantes cambios legislativos en numerosos países respecto al consumo de cannabis con fines medicinales y/o recreativos, que han facilitado su accesibilidad. Actualmente, Uruguay, Canadá y algunos estados de EE.UU. han legalizado el consumo recreativo, aplicando distintos modelos legislativos. El objetivo de la presente revisión es analizar los efectos que ha tenido la legalización del cannabis recreativo sobre su consumo y sus consecuencias. En general, las evidencias indican que la legalización se ha asociado a un descenso en el precio, mayor concentración de THC (potencia), mayor diversidad de presentaciones para su consumo, una menor percepción de riesgo y un incremento en el consumo en adultos y de forma moderada en adolescentes (aunque sea ilegal el consumo para ellos), así como un aumento de las consecuencias adversas derivadas del consumo en la salud pública. Se ha producido un descenso en los arrestos relacionados con el consumo, pero el mercado ilegal sigue utilizándose de forma habitual. No se ha detectado un incremento de la demanda de tratamiento por este consumo. Por el momento, estos cambios legislativos no han conseguido alcanzar sus objetivos principales que eran suprimir el mercado ilegal y proteger a los grupos más vulnerables, mientras que, por el contrario, parecen implicar un incremento de algunos aspectos negativos asociados al consumo de cannabis. Sin embargo, teniendo en cuenta que la mayoría de estos cambios legislativos han entrado en vigor hace relativamente poco tiempo, se requiere un periodo de seguimiento mayor para poder extraer conclusiones definitivas.

Palabras clave: cannabis, legalización, uso recreativo, consecuencias del consumo, salud pública

■ Received: June 2021; Accepted: October 2021.

■ ISSN: 0214-4840 / E-ISSN: 2604-6334

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The last two decades have seen a growing number of countries introduce legislative changes governing the use of cannabis and its derivatives. In general, these legal modifications favouring sales and decriminalizing consumption have come about after a referendum to consult the population. Governments have thus responded to social and political pressure for legalization resulting from the growing acceptance of the potential therapeutic benefit of cannabis among citizens of these countries. These changes have generated a political and social debate in many countries, including Spain, about the desirability of decriminalization and legalization and thereby also regulating the sale of cannabis for “recreational” use.

Among the main arguments put forward by defenders of recreational cannabis legalization (Degenhardt et al., 2013; Felson, Adamczyk & Thomas, 2019; The NORML Foundation, 2021) the following can be highlighted:

- Cannabis is commonly used by young adults and causes less harm to health than other legal drugs such as alcohol, tobacco and opioids.
- The consequences of criminalizing cannabis use are more harmful to the user than the use itself as it can lead to arrest and a criminal record.
- Criminalization of cannabis use disproportionately affects minority or disadvantaged populations. In many countries, being penalized for violations related to use reduces future employment opportunities, thereby increasing social inequalities, although this may not be the case in Spain.
- Legalization of cannabis is a better social policy than criminalization because:
 - a. It reduces or eliminates the illicit market, thereby reducing organized crime and the police resources needed to control or eradicate illegal trafficking.
 - b. It allows control to be exercised over the cannabis-using population, minimizing access of the most vulnerable population segments in particular, such as adolescents, and controlling the quality of the product used in terms of delta⁹-tetrahydrocannabinol (THC) content, the main psychoactive cannabis compound, and contaminants (fungi, pesticides, heavy metals), thus leading to an improvement in public health.
 - c. It benefits the state financially by allowing revenues to be raised in the form of taxes on the production and sale of cannabis products.

The main argument against legalizing cannabis for recreational purposes is the potentially negative impact on public health (Isorna, 2017; National Academies of Sciences, Engineering, and Medicine, 2017; Nazif-Muñoz, Oulhote & Ouimet, 2020; Steinemann, Galanis, Nguyen & Biff, 2018), given the possibility that:

- Cannabis use may increase and the risk perception in the population may decrease, leading to subsequent

increases in high-risk consumption patterns and associated disorders, mainly in vulnerable groups.

- Traffic and work accidents related to cannabis use may increase.
- The incidence of respiratory diseases, mental disorders and poisonings may rise.
- The use of alcohol, tobacco and other drugs may increase.

While several studies have tried to analyze some of these consequences separately in states where cannabis has already been legalized for all uses (Chung et al., 2019; Grigsby, Hoffmann & Moss, 2020; Hall & Lynskey, 2020; Nazif-Muñoz et al., 2020; Steinemann et al., 2018), there has been no studies addressing all consequences globally and possible repercussions in all countries where it has been legalized.

The objectives of this review are therefore: 1) to present the current situation at a global level regarding the legalization of cannabis; 2) update the existing evidence on the impact of cannabis legalization in various areas of public health in countries where recreational use has been legalized, and 3) analyze whether the legal market has led to changes in how cannabis is used.

Material and methods

A PubMed database search was conducted with the keywords “cannabis” OR “marijuana” AND “legalization” over the last 10 years. The search was conducted on January 5, 2021.

The inclusion criteria were: original or review articles focusing on the changes that recreational cannabis legalization has caused in the way it is used, consequences for public and user health, changes in the prevalence of use and changes in the product and forms of use. Articles written in English or Spanish were considered for inclusion.

Letters to the editor, comments from authors on legalization and studies carried out prior to legalization in those states where it then became legalized were excluded.

The initial search obtained 1,877 references, of which 562 articles were chosen after reviewing abstracts and being assessed for inclusion by the 4 authors of the present study. Likewise, the reference lists of the selected articles were considered and three articles published after the date of the search were included. The final selection contained 109 articles considered to meet the inclusion criteria.

In addition, information on the status of cannabis legalization was obtained by consulting government sources and official bodies in each of the countries included in the study.

Results

1. Current situation of cannabis legalization

Figure 1 shows the current situation worldwide regarding the legalization of medicinal and/or recreational cannabis to date. Only three nations, Uruguay, the USA (not at federal level) and Canada, have passed laws decriminalizing the production and use of cannabis and regulating distribution among the adult population for recreational purposes. Below is a summary of the regulatory models adopted by each of these countries.

Uruguay

This was the first country to fully legalize production, distribution, marketing and use of cannabis for both medicinal and recreational purposes. In 2013, a law (19,172) was passed that allowed people aged over 18 years to register in a state database as cannabis users and thereby obtain permission to use it legally (República de la Presidencia Oriental de Uruguay, 2014). Article 4 of this law defined its main objectives: “*The purpose of this law is to protect the inhabitants of the country from the risks inherent in involvement with illegal trade and drug trafficking, seeking, through state intervention, to tackle the devastating health, social and economic consequences of the problematic use of psychoactive substances, as well as to reduce the incidence of drug trafficking and organized crime*”. Three ways of obtaining the product were considered: private production (up to 6 female plants/household), membership of a club of cannabis producers (maximum

45 members, 99 cultivated plants and maximum annual production of 480g/person) or purchase of cannabis in pharmacies licensed to supply it with state-regulated pricing (up to 40g/month). However, the advertising of cannabis-related products and the sale of edible products containing this substance were not allowed. Despite being pioneers in proposing this highly regulated and state-controlled cannabis management model, it has not been fully implemented successfully to date due, according to the authorities, to a production deficit, financial constraints or the scarcity of authorized points of sale, among other reasons. Thus, only 1.3% of the country’s pharmacies have obtained a license to sell cannabis and only 27.3% and 38.4% of Uruguayan users of recreational and medicinal cannabis, respectively, say that they acquire it through any of the legal channels, according to the latest national survey published on drug use (Observatorio Uruguayo de Drogas, 2019). The same survey revealed that up to 84% of users in the last 12 months were not registered as users in the state database (Observatorio Uruguayo de Drogas, 2019).

USA

Although cannabis remains an illegal substance at the federal level, most states have laws that allow medical cannabis to be used under prescription, and up to 16 states, plus the District of Columbia (DC), have also legalized production, processing and recreational use in the population aged over 21 years (Figure 2). Colorado and Washington were

Figure 1

Visual summary of the legalization of cannabis for medical (green) and recreational (orange) use worldwide. The year given is when legal modifications allowing this use were introduced. The situation in the USA (light orange), where cannabis has been legalized in many states but not at federal level, is detailed in Figure 2. Information obtained from government sources in each country and the United Nations Office on Drugs and Crime (UNODC, 2020)

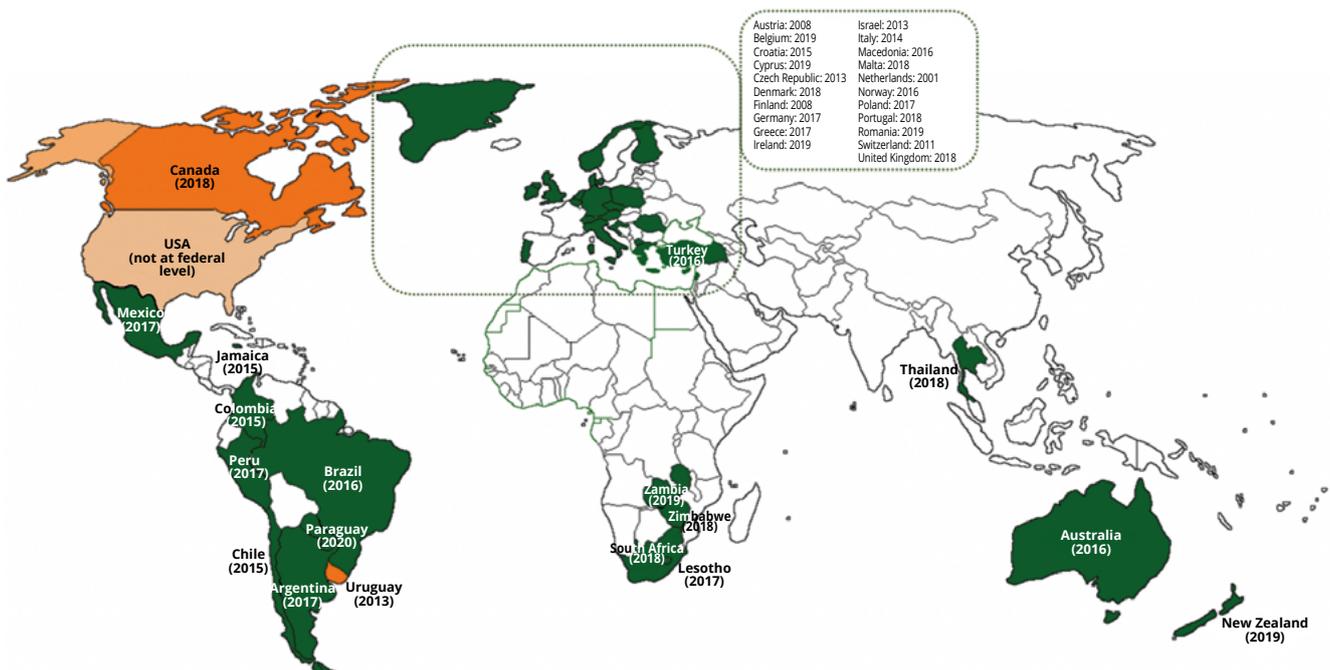


Figure 2

Current status of cannabis legalization for medical (green) and recreational (orange) use in the USA. The year given is when the legal modifications allowing this use were introduced. In most states where cannabis has not been legalized for any use (white), the processing and use of cannabidiol (CBD) products is allowed. Information obtained from government sources (Department of Justice, The United States)

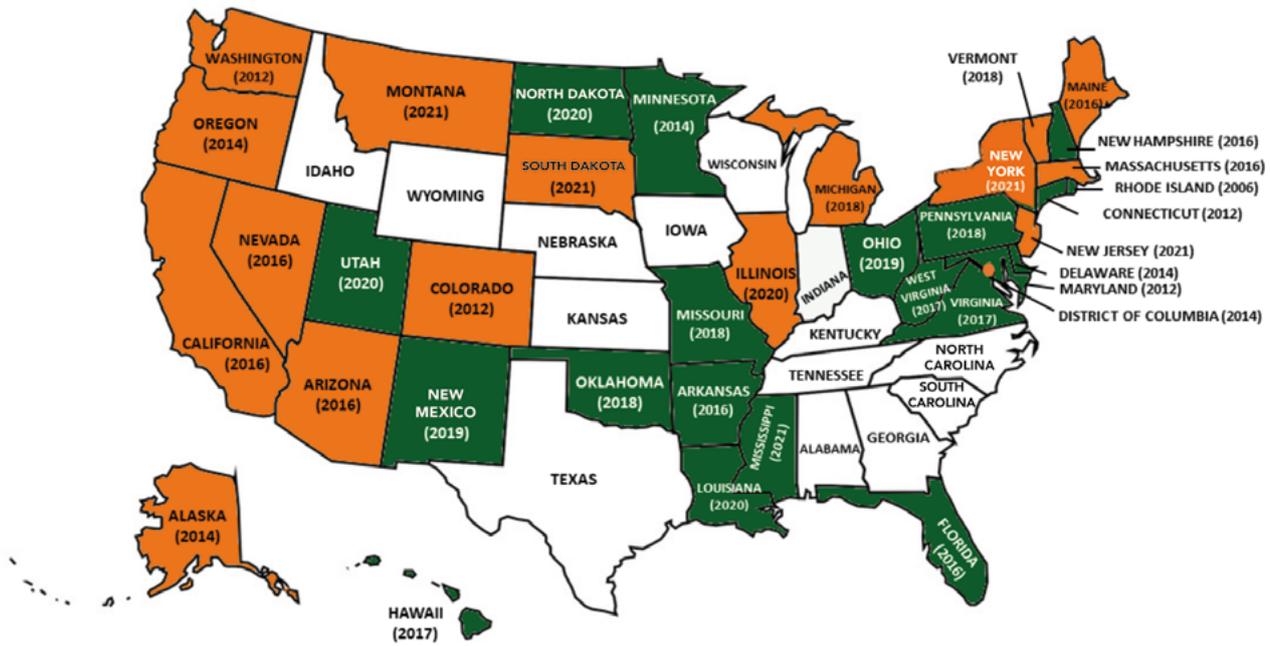
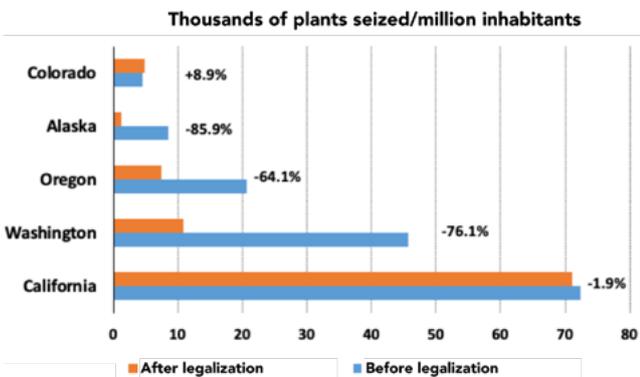


Figure 3

Average annual seizures (expressed in thousands of plants) carried out by the DEA, within the program for the reduction/eradication of illegal cannabis cultivation in the USA (Drug Enforcement Administration, 2020), before (blue) or after (orange) cannabis legalization in each state between 2011-2019. Standardized data per million inhabitants (according to the United States Census Bureau, 2021) are included for states in which recreational cannabis was legalized in 2012 (Colorado and Washington) or in 2014 (Alaska and Oregon), plus California (legalized recreational cannabis in 2016) as it is the most populous state and where cannabis has traditionally been most cultivated and used



the first states to permit recreational use in 2012, followed by Oregon and Alaska in 2014; for this reason, most studies focussing on the consequences of cannabis legalization are based on data collected in these states. There is no single model in the USA for regulating recreational cannabis. For example, while the production of cannabis for personal use is legal in Vermont and DC, selling this substance remains illegal. Following the commercial models initiated in Colorado, California or Washington, however, most states chose to authorise companies to produce and sell cannabis for profit through networks of dispensaries licensed for the retail sale of cannabis and related products, which are then taxed on their sale price. Many of these states have limited the amount of cannabis an adult can legally carry to 28.5g (Hall et al., 2020). These models drive a thriving cannabis industry in the US, with a significant business volume which is growing annually. While the sector had a turnover of 8 billion dollars in 2017, this reached 11 billion the following year and it is estimated that these figures may double in just four years (Heinrich, 2018). The legal cannabis industry has an interest in promoting cannabis use and employs marketing strategies common to other business sectors, including the increasing use of social media (Cavazos-Rehg et al., 2019; Krauss et al., 2017).

According to data published by the US Drug Enforcement Administration (DEA), the government agency responsible for combating drug trafficking, seizures of illegal cannabis

crops have dropped significantly in some of the states that have legalized recreational cannabis in adults the longest, such as Alaska, Oregon or Washington. However, they have remained stable or even increased in key states in the cannabis movement such as California or Colorado (Figure 3) (Drug Enforcement Administration, 2020).

Canada

In October 2018, the Canadian government passed the *Cannabis Act (S.C. 2018, c.16)*, thus becoming the second country to legalize cannabis for recreational purposes (Government of Canada, 2018, 2020). The main motivation behind this law was to eliminate the illicit cannabis market and regulate the production and sale of this substance to protect public health and young people especially. The government of each of the provinces and territories licenses and regulates cannabis producers and collects taxes. Unlike the prevailing model in the USA, Canada prohibits cannabis advertising except under very restrictive conditions guaranteeing that minors have no access to the promotion of the products, and it is mandatory for products to be sold with health warnings. Provincial government regulation is comparable to that of alcohol sales, with retail sales of cannabis for profit allowed for licensed distributors, who in many cases also distribute alcohol.

According to data published by the Canadian government in the first nationwide survey on cannabis use that covered a full year after the legalization and regulation of recreational cannabis sales, cannabis use increased slightly (2% more of the population acknowledged using it in the last 12 months), especially among the population over 25 years of age, as well as the use of cannabis of legal origin. Nevertheless, only 37% of users acknowledged that they always purchase the product from legal sources, while up to 20% always obtained cannabis illegally (Government of Canada, 2021).

2. Effects of legalization on the product

2.1. Impact on potency (THC concentration)

The market for recreational cannabis has evolved towards greater product diversity and potency (Orens, Light, Lewandowski, Rowberry & Saloga, 2018). In the US, average THC potency in these types of products increased from 8.9% in 2008 to 17.1% in 2017, while the THC:CBD ratio increased dramatically from 23 in 2008 to 104 in 2017 (Chandra et al., 2019; ElSohly, Chandra, Radwan, Gon & Church, 2021). According to data from the DEA, the last ten years have seen a general increase in the potency of illicit cannabis in the USA, from approximately 10% in 2009 to 14% in 2019, although this increase has been observed in all states and the number of samples received in the last 5-6 years has decreased due to the legalization of marijuana for medical or recreational purposes in many

USA states (ElSohly et al., 2021). In 2016, in response to this rise, the state of Colorado proposed to limit all types of cannabis products to 15-16% THC, but this initiative failed (Shi, Cao, Shang & Pacula, 2019). Estimates in Canada suggest similar (or greater) increases in cannabis potency. Specifically, a study based on monitoring the potency of legal and illegal cannabis products in the two months after the federal legalization of cannabis use for non-medical purposes found an average THC concentration of 16.1% in the legal market and 20.5% in the illegal market (Mahamad, Wadsworth, Rynard, Goodman & Hammond, 2020).

In the states where it has been legalized, despite clear differences between “medicinal” and “recreational” use (mainly in leisure or recreational sites), average THC concentration advertised in online stores for medicinal purposes (19.2% \pm 6.2) is similar to that marketed for recreational purposes (21.5% \pm 6.0) when compared between states with different programs, or between medicinal programs and recreational programs within the same states (Cash, Cunnane, Fan & Romero-Sandoval, 2020). Lower CBD concentrations are found in products with higher THC, irrespective of medicinal or recreational use, with THC content greater than 15% (between 70.3% and 91.4% of products) (Cash et al., 2020).

It therefore appears that legalization has coincided with an overall increase in the potency of cannabis in general, with illegal cannabis being the one with the highest THC content (Mahamad et al., 2020).

2.2. Impact of legalization on the price of cannabis

In Canada, a year before cannabis was fully legalized, the mean price in legal establishments per gram of marijuana was CA\$7.43, down from CA\$9.06 per gram in 2010 (Statistics Canada, 2018). Once legalized, the same body estimated the average price at CA\$6.80 in 2018, with provincial averages ranging between CA\$5.86 and CA\$9.51 per gram (Statistics Canada, 2018). Another study found that prices decreased between 9% and 27% as purchase volume increased (Mahamad & Hammond, 2019). Regarding the price of illegal cannabis, according to the *Price of Weed* database in the pre-legalization period (2011-2015), the average street price per gram was CA\$7.69, in a period when medical cannabis (which was legal) cost an average of two dollars more per gram (Public Safety Canada, 2017). Currently the average street price of cannabis (illegal sale) paid by users is approximately CA\$6.22 per gram (Sikorski, Leos-Toro & Hammond, 2021). In Canada, four out of ten consumers claim to buy cannabis on the illegal market, probably due to the price difference compared to the legal market. There are two possible explanations for this fact: the first is that while a gram of legal marijuana costs an average of CA\$9.51, the illegal market price is 51% lower, at CA\$6.51, (Mahamad

Table 1
Changes in the increase in THC levels (potency)

Author (year)	Place	Method	Results	Observations
Cash et al. (2020)	USA	Study comparing differences in supply and sales between medicinal and recreational cannabis in 653 dispensaries.	The mean THC concentration advertised online in medicinal programs was similar ($19.2\% \pm 6.2$) to recreational programs ($21.5\% \pm 6.0$) when comparing states with different programs.	The lowest CBD concentrations were found in products with more THC.
Chandra et al. (2019)	USA	Longitudinal study (2008-2017) of police seizures of cannabis.	Mean THC:CBD ratio increased from 23 in 2008 to 104 in 2017. Increase in the proportion of seized hash oil samples and their average THC concentration (6.7-55.7%) from 2008 to 2017.	Trends in the last decade suggest that cannabis is becoming an increasingly potent product in the USA.
ElSohly et al. (2021)	USA	Analysis of 14,234 cannabis plant samples by the DEA in the last 10 years.	Illicit cannabis potency rose from approx. 10% in 2009 to approx. 14% in 2019.	The last two years saw a decrease in the THC:CBD ratio.
Mahamad, et al. (2020)	Canadá	Study of 185 legal and 944 illegal retailers.	Marijuana prices fell and potency increased. The mean price of legal marijuana was 19% higher than illegal products.	In the 2 months after legalization, illegal cannabis was less expensive and had higher THC on the label than legal cannabis.
Orens et al. (2018)	Colorado	Study of prices, potency, patterns of use in dispensaries.	Mean prices for adult use cannabis products and derivatives fell significantly from 2014 to 2017.	Trends reflect an increasingly competitive market. Producers and sellers improved their operations.
Shi et al. (2019)	EE.UU.	Assessment of sales in cannabis dispensaries.	The best-selling product is marijuana for smoking. Sales of cannabis-infused concentrates, edibles and beverages, etc., also increased.	THC rose from 3.4% in 1993 to 8.8% in 2008 and more dramatically after cannabis legalization from 16% to almost 20% during 2014-2017.

et al., 2020). Taxes account for approximately one dollar of the price paid in authorized stores. Added to this, the number of cannabis stores in Canada today is around 400, meaning that for every 100,000 residents there is only one shop; in Colorado this indicator is 10 stores per 100,000 inhabitants (Mahamad et al., 2020; Orens et al., 2018). Taxes based on the level of THC in edibles and cannabis extracts have been proposed in Canada, but applying these taxes could be challenging due to costs and difficulties in checking THC concentrations in cannabis products (Mahamad et al., 2020; Orens et al., 2018).

In the USA, data from household surveys and the dispensaries themselves indicate that prices fell by as much as 50% in the first states to legalize recreational cannabis (Smart, Caulkins, Kilmer, Davenport & Midgett, 2017); prices fluctuated within the states themselves between urban or mountainous areas, and in states bordering others in which it is not legalized, with prices ranging from \$11.75 to \$5.79 and at an average of \$6.92 per gram (Department of Revenue Colorado, 2019; Hunt & Pacula, 2017; Wilson, Freeman & Mackie, 2019).

In Colorado, mean prices declined significantly from 2014 to 2017. The largest falls were seen in cannabis concentrates (hash oil, *dabs*) which fell 47.9%, from \$41.43 to \$21.57 per gram. The price of a gram of marijuana decreased 62%, from \$14.05 to \$5.34., while the price of food products and

herbal tea packages containing 100 mg of THC remained relatively constant at around \$18, with no clear trend over time. This same trend was also observable in medical cannabis, with the average price per gram of medical cannabis falling by 40.9% from \$5.55 to \$3.28 per gram between 2014 and 2017. Over the same period, the price of concentrates on the medical cannabis market fell by 34.6%, from \$25.83 to \$16.89 per gram. Medical infused edibles sold in 100mg THC packages consistently cost around \$9, with a slight downward trend over time (Orens et al., 2018) (Table 2).

In Uruguay, the fixed purchase price of cannabis is set by the government in order to compete with the black market. The sale price of the 5-gram presentation in the 14 pharmacies dispensing cannabis is 350 Uruguayan pesos (about €6.63) (Instituto de regulación y control del cannabis, 2021).

2.3. Changes in post-legalization presentation, forms and patterns of use

The supply of new high-THC products, such as cannabis concentrates, vaping oils, edibles, and beverages, is more prevalent in Canada and “legal” states of the USA than in “illegal” states (Goodman, Wadsworth, Leos-Toro & Hammond, 2020) (Table 3). In a study on the use of cannabis among young people in Canada, the USA and

Table 2
Effects of legalization on taxes and the price of cannabis

Author (year)	Place	Method	Results	Comments
Department of Revenue Colorado (2019)	Colorado	Analysis of prices in state dispensaries.	Prices fell steadily every year after legalization.	
Hunt and Pacula (2017)	USA Colorado and Washington	Longitudinal surveys on prices paid by consumers and data extracted from websites on prices in three states with medical marijuana that eventually legalized recreational marijuana.	Different prices according to state. Colorado: recreational \$9.94 and \$7.98 medical. Orlando: no differences, \$8.51 for medical vs \$8.63 recreational. Washington quite similar, \$10.65 medical versus \$10.40 recreational.	Differences between marijuana prices at dispensaries and consumer self-reports. Dispensaries used strategies to attract consumers.
Mahamad et al. (2020)	Canada	Availability, price and potency of legal and illegal cannabis in Canada following the legalization of recreational cannabis.	Marijuana prices fell, potency increased. The mean price of legal marijuana was 19% higher than that of illegal.	
Orens et al. (2018)	Colorado	Report. Longitudinal study.	Prices of recreational and medical cannabis and all its derivatives fell steadily from 2014 to 2107.	Greater falls (47.9%) in cannabis concentrates, from \$41.43 to \$21.57.
Sikorski et al. (2021)	Canada	Online survey sampling Canadians aged 16-30 (N = 868).	Mean marijuana use was 17.8 g/month, 17.4 g/ month, and 9.4 g/month among medically licensed and non-medically licensed cannabis users.	31.5% and 13.2% of current users reported knowing the levels of THC and of CBD, respectively, in their cannabis.
Smart et al. (2017)	Washington	Analysis of data available from Washington's cannabis traceability system from July 7, 2014 to September 30, 2016.	The market share of extracts for inhalation increased by 145.8% between October 2014 and September 2016 and now represents 21.2% of sales.	Mean THC level of cannabis extracts is more than triple that of cannabis flowers (68.7% vs. 20.6%).
Statistics Canada (2018)	Canada	Survey.	The price of non-medical cannabis fell from \$9.06 in 2010 to \$7.43 in 2017.	The price of medical cannabis went from \$9.06 in 2010 to \$8.18 in 2017.

England, Hammond, Wadsworth, Reid and Burkhalter (2021) showed that while the prevalence of the use of oils/liquids for vaping and the use of cannabis extracts (oil, wax and shatter) increased in all countries, the increase was significantly greater in Canada and the USA. Thus, the prevalence of vaping oils/liquids in the USA increased from 24.2% in 2017 to 52.1% in 2019.

In Uruguay, on the other hand, no edibles, oils, creams or alternative products are permitted, and pharmacies can only sell cannabis buds produced by the two companies contracted by the government (Cerdá & Kilmer, 2017).

After legalization, the most common method of use in Canada continues to be smoking, with estimates ranging between 84% and 95%. However, ingesting edibles made with cannabis oil has been gaining in popularity (Borodovsky, Crosier, Lee, Sargent & Budney, 2016), with use estimated at between 18% and 49%. In addition to traditional cannabis edibles (i.e., baked goods), other THC oral products such as candies, oils and tinctures, have become common in legal retail markets (Spindle, Bonn-Miller & Vandrey, 2019). Both therapeutic and recreational users who do not want to be exposed to cannabis smoke may demand edible cannabis products (Gourdet, Giombi, Kosa, Wiley & Cates, 2017), and it has been suggested that edibles reduce respiratory risks associated with the use of

smoked cannabis (Russell, Rueda, Room, Tyndall & Fischer, 2018). However, a major concern with edible consumption is the delayed and often unpredictable onset and duration of psychotropic effects as a result of the slower and more variable absorption of THC (Huestis, 2007).

Several studies in the USA have revealed a relationship between the legalization of cannabis use (medicinal and/or recreational) and an increase in the probability of consuming new presentations among young people, especially edibles and vaping (Borodovsky et al., 2016; Borodovsky et al., 2017; Shi & Liang, 2020). In this sense, the legalization of home cannabis cultivation increases the probability that people will make cannabis edibles at home, while the authorization of sale in cannabis dispensaries increases the likelihood of this type of product being purchased (Borodovsky & Budney, 2017).

Another way of using cannabis that has become popular in states where it has been legalized is vaporization (Borodovsky et al., 2016), with use estimated to range from 13% to 45% (Government of Canada, 2018). Vaporization devices typically operate at temperatures that do not burn the cannabis product, but rather “*aerosolize the cannabinoids*” for inhalation, thus likely exposing the user to less toxicity (Spindle et al., 2019). However, the use of cannabis concentrates in vaporizers has been linked to increased

risk of lung injury and other acute damage (Borodovsky, Cavazos-Rehg, Bierut & Grucza, 2020). It is worth noting that concerns about vaping have been raised as a result of recent lung injuries and deaths linked to vaporizer use, such as the series of 98 cases in Wisconsin and Illinois documented in 2019 (Ghinai et al., 2019).

With legalization, other new trends in cannabis use have also gained popularity, such as the combustion and inhalation of cannabis concentrates such as waxes, “dabs” and “shatter” (Goodman et al., 2020; Spindle et al., 2019).

These products tend to have very high THC concentrations, are commonly used for the increased THC-induced “high”, and have been associated with a number of acute harms (Matheson & Le Foll, 2020). *Dabbing* usually results in very high and immediate doses of THC (Al-Zouabi, Stogner, Miller & Lane, 2018), and the use of “dabs” has been linked to cases of acute psychosis, cardiotoxicity and respiratory failure, even though exact causality remains uncertain (Al-Zouabi et al., 2018).

Table 3
Impact of legalization on the presentations, forms and patterns of use

Author (year)	Place	Method	Results	Comments
Al-Zouabi et al. (2018)	USA	Review of studies related to THC through butane extraction.	The use of butane-extracted hash oil consumed by “dabbing” had high THC content and the presence of impurities such as unpurged butane.	Public educational campaigns can focus on dispelling inaccuracies and false sense of security linked to amateur production.
Borodovsky and Budney (2017)	USA	Online survey of adult users.	Users in states where cannabis is legal have grown more at home and have used and purchased more edibles.	Those who have grown cannabis are more likely to make edibles than those who have never done so.
Borodovsky et al. (2017)	USA	Online survey of young cannabis users aged 14 to 18.	States where cannabis is legal and with the highest number of dispensaries were linked to a higher likelihood of trying vaping and edibles.	Laws appear to influence the probability and age at which young people try alternative methods of using cannabis.
Cerdá et al. (2017)	Washington and Colorado versus other states	Compares use in the month before and after legalization versus the other states, national survey (MTF).	Use in Washington increased in 13-15-year-olds, but not in Colorado and not in 17-year-olds.	Low risk perception. Short period after legalization.
Ghinai et al. (2019)	Illinois and Wisconsin	Interviews with nicotine and cannabis vape users.	A high percentage of patients reported using Dank Vape cartridges, which appears to be a highly counterfeited brand.	Lung injuries associated with e-cigarettes after use of products containing THC and nicotine.
Goodman et al. (2020)	Canada and USA	Cross-sectional survey.	Users in legal states significantly were more likely to consume products high in THC than users in illegal states of the USA or Canada and more likely to drive after cannabis use.	
Gourdet et al. (2017)	Alaska, Colorado, Oregon and Washington	Review of official data and surveys.	Wide variation in the regulation of labelling and packaging of THC edibles in the 4 states.	There are inherent difficulties in the enforcement of laws on the labelling, packaging and manufacture of edibles.
Hammond, Chaney, Hendrickson, and Sharma, (2020)	USA	Review (2008/2017).	Legalization has had mixed effects on the health of US adolescents, including the potential benefits of decriminalization and negative outcomes such as rise in car crashes, ED visits, and hospitalizations.	
Matheson and Le Foll (2020)	Colorado	Review.	Review of the increase in acute harms linked to high potency cannabis in states where it is legal.	
Spindle et al. (2019)	USA	Review of new products for use after legalization.	Vaporized cannabis provided higher concentrations of cannabinoids and produced stronger effects, compared to equivalent doses of smoked cannabis.	Delayed effects after use increases the likelihood of acute overdose incidents.
Shi y Liang (2020)	USA	Analysis of data at national level, 2010-17.	Increase in cannabis exposures reported to the poison data system after commercialization of recreational cannabis. Increased availability and accessibility among minors, possibly through purchase by third parties.	Price reduction. Enabled marketing activities at the point of sale. Increased the appeal of cannabis products. The availability of cannabis-derived products increased as did, in turn, the use of alternative methods of use.

At the same time, with legalization, the cannabis industry has commercialized a plethora of diverse products, such as topicals (lotions, balms, creams, etc.), sublingual sprays, and even rectal and vaginal suppositories (Spindle et al., 2019). Very little is known about the use of these new cannabis-derived products (Matheson & Le Foll, 2020).

3. Impact on cannabis use

According to Budney and Borodovsky (2017), the legalization of cannabis use has led to a series of sales and distribution opportunities that may involve increasing use and the possible development of cannabis use disorder (CUD). They highlight the following:

-
- Greater availability.
 - More accessibility.
 - Lower cost.
 - More power.
 - Greater variety of presentation (vapes, foods, extracts, oils ...).
 - Higher concentration of THC.
-
- Lower perception of risk.
 - Normalization of use.
 - Advertising.
 - Greater social and family acceptance.
 - Earlier start of consumption due to greater accessibility and lower perception of risk.
-

Legalization implies potentially increased use among existing consumers and the likelihood that non-users will try it. Thus, over 10% of non-consumers expressed an intention to try it after legalization in the United States (Palamar, Ompad & Petkova, 2014), similar to the data from the ESTUDES survey in Spain (Observatorio Español de las Drogas y las Adicciones, 2020). In Canada, 18.5% of those aged over 15 years, especially the youngest (15-24), also said they intended to try it or increase use after legalization (Sandhu, Anderson & Busse, 2019).

3.1. Changes in risk perception among users and the general population

The broader use and greater availability of cannabis associated with legalization may lead to a decrease in the perception of the harm produced by it, a perception which is already generally low, as indicated in surveys in Spain such as ESTUDES (Observatorio Español de las Drogas y las Adicciones, 2020). A lower perception of risk regarding the use of a substance is associated with an increase in use (Budney & Borodovsky, 2017).

This lower perception of risk, both of the development of addiction and secondary mental problems, occurs

specifically among users rather than non-users, as detected in an online survey in 2017 prior to legalization in Canada with subjects aged between 16-30 years (Leos-Toro, Fong, Meyer & Hammond, 2020). This same trend was observed in another survey conducted at national level in the USA in states where it had been legalized compared to those where it had not (Okaneku, Vearrier, McKeever, LaSala & Greenberg, 2015). In Canada, users also reported greater ease in recovering from addiction without the need for treatment (Cunningham, 2020).

In a qualitative study with students in Nevada, it was shown that there was majority support for legalization, a sense of greater security and less social (acceptance by others) and legal risk (legal problems derived from use) in this social segment for a short time after legalization, although, paradoxically, the black market continued to be used due to its lower prices and age restrictions (Amroussia, Watanabe & Pearson, 2020). A survey among students in Washington in 2014 also indicated that legalization led to a more positive attitude towards cannabis and greater intention to use, and could lead abstinent subjects or occasional users to a more frequent use of cannabis (Clarke, Dodge & Stock, 2018). In addition, legalization for recreational purposes made subjects consider that use was more beneficial for the management of pain or affective symptoms (Steigerwald et al., 2020). Surveys conducted by Fleming, Guttmanova, Cambron, Rhew and Oesterle (2016) and Brooks-Russell et al. (2019) also observed this decrease in risk perception among young people in Colorado.

Legalization may also lead to changes in the perception of risk on the part of parents and more permissive attitudes towards use by children. A study by Kosterman et al. (2016) in Washington, interviewing 395 parents between 1985 and 2014, revealed an increase in the approval of adult use and a decrease in the perception of use-related harm. However, its use by young people was negatively perceived. In addition, parents were seen to increase use, with 34% having used it during the previous year. Interestingly enough, quite a few parents were unaware of the legal age for cannabis use.

3.2. Changes in consumption in adolescents and young people

One of the major concerns in connection with legalization is the potential increase in use among young people, given their greater vulnerability and possible repercussions at academic, cognitive and mental-health levels, although in all states and countries where it has been legalized, cannabis use is prohibited at this life stage (under 18 in Uruguay and Canada, under 21 in the USA).

A considerable number of studies have assessed the impact of medical cannabis legalization on use among young people (Anderson & Rees, 2014; Anderson, Hansen, Rees & Sabia, 2019; Cerdá, Wall, Keyes, Galea & Hasin,

2012; Choo et al., 2014; Harper, Strumpf & Kaufman, 2012), generally reporting few repercussions. One meta-analysis indicates that there is no association between the legalization of medical cannabis and its use in adolescents (Sarvet et al., 2018). However, the advertising of cannabis products for therapeutic uses in some states may be influencing the perception of risk. A California study found that adolescents who had seen medical marijuana advertisements on billboards, magazines, or other media in the past three months were more likely to use cannabis and had a greater intention to do so up to a year later (D'Amico, Miles & Tucker, 2015).

In addition, despite the specific prohibition in minors, there is an interest in discovering whether legalization of recreational use influences the use by this population given the possibility that the legal market may be accessed through friends or family and in an environment of greater normalization and lower risk perception, which could favour its use. Melchior et al. (2019) in a recent meta-analysis concluded that measures liberalizing use led to increased consumption. These authors point out that with the legalization of medical cannabis, there was no clear effect on use by young people (three studies indicated a decrease and four an increase) but with the legalization of recreational cannabis, a slight increase was observed. It is argued that this increased consumption may be due to changes in the information regarding use, lower risk perception, greater availability and a decrease in legal and illegal market prices (Table 5). Other studies, such as that by Kerr, Bae, Phibbs and Kern (2017), have found increased rates of marijuana use in Oregon relative to other states without legalization, but only among students who reported recent heavy alcohol use.

A 2018 survey of young people aged 16-19 years on vaping and ways of smoking tobacco and cannabis showed higher cannabis use in Canada (16.65%) and the USA (13.8%) than in the United Kingdom (9%) in any of its forms (Hammond et al., 2021). This seems to indicate that greater previous use existed in countries where it has been legalized, which may favour the positive attitude towards legalization or a lower perception of risk (Brooks-Russell et al., 2019; Fleming et al., 2016).

Most studies (Table 5) were based on online surveys or obtained data from previous surveys, but the different methodologies of these surveys may explain part of the discrepancy in the results. Dilley et al. (2019), evaluating information from two different surveys, observed disparate results. While a survey used in the study by Cerdá and Kilmer (2017) detected a 4% increase in use among 15-year-old students, another survey carried out in state schools found a 2% decrease in 13- and 15-year-old students and no change among 17-year-old students in both. Midgette and Reuter (2020) also point out the importance of the cited sources, indicating considerable disparities in the prevalence figures between states and the doubts about the representativeness of some surveys, but nevertheless concluding that legalization does not influence the prevalence of use in adolescents.

It appears that the developments seen after legalization depend on the level of previous use, with greater increases among existing users (Rusby, Westling, Crowley & Light, 2018). In addition, changes regarding use will likely be perceived several years after legalization takes place, with potentially a stronger effect after five years (Shi et al., 2019).

Table 4
Changes in risk perception associated with the legalization of recreational cannabis

Author (year)	Place	Method	Results	Comments
Amroussia et al. (2020)	Nevada	Focus groups, 32 students, 18-24 years old, three groups (non-, occasional, regular users). Topics: legalization, harm reduction, acceptance, purchasing security.	Greater social and family acceptance. Greater accessibility. More security when buying, more reliability, more variety. Legalization not considered to affect use. Legalization does not eliminate illegal market. Black market used for reasons of cost and age restriction. Those under 21 are also supplied by the legal market through friends and family.	More positive attitude towards cannabis and more intention to use. Non-users thought they might try it in the future as it was legal. They showed little knowledge of regulation but supported legalization. The sense of security was higher.
Clarke et al. (2018)	Washington	Student surveys in 2014.	More positive attitude towards cannabis and more intentions to use.	
Kosterman et al. (2016)	Washington	Interviews with 395 parents from 1985 to 2014.	Increased approval of adult use and decrease in the perception of harm related to use; however, negative perception of use by young people maintained. Increase in use observed among using parents, with 34% having used it during the previous year.	
Steigerwald et al. (2020)	USA, divided into states with and without legalization.	National survey, N=16,280, 56.3% responded (9,003).	In legal states, use was felt to be more beneficial for pain, anxiety-depression management, improved appetite, and safer than tobacco.	

Table 5
Changes in use among adolescents and young adults

Author (year)	Place	Method	Results	Comments
Anderson et al. (2019)	USA, differentiating between states with and without legalization.	Survey of risk behaviours in young students. 1993-2017. N = 1,414,826.	Fall in use. No change in legal medical cannabis. 8% drop in recreational cannabis use and lower frequency of use.	Greater difficulty for adolescents to buy illegal cannabis as vendors are replaced by dispensaries that require proof of age.
Brooks-Russell et al. (2019)	Colorado	Student survey in 2013 (prior to implementation) and 2015 (18 months after implementation).	Little change in use (previous month and lifetime) but decrease in risk perception among adolescents.	
Cerdá and Kilmer (2017)	Washington and Colorado versus other states	Use compared in the month before and after legalization versus the other states, by national survey (MTF survey).	Use in Washington increased in 13-15-year-olds, but not in Colorado and not in 17-year-olds. Little perception of risk.	Low risk perception. Short period after legalization.
Cerdá et al. (2020)	USA, national	National survey of drug use, 2008-2016. N = 505,796. Assessed use before and after legalization. Groups: 12-17 years, 18-25 years and over 26 years.	CUDs in 12-17-year-olds increased from 2.18 to 2.72%; 25% higher than in states without legalizing recreational use.	Noticeable moderate but consistent increase in use and CUDs.
Estoup et al. (2016)	Washington	262 students in school interventions for drug use between 2010-15.	No increase in use (three-month use) after legalization.	
Graves et al. (2019)	Washington	Youth surveys 2010-16, 76,000 young people annually.	Greater use among young workers than non-workers, increase in 17-year-olds, decrease in 13-15-year-olds.	
Harpin et al. (2018)	Colorado	Students aged 11-17 years, survey in 2013 and 2014, n = 24,171.	No changes in previous-month use, greater perception of availability.	
Jones et al. (2018)	Colorado	Students (22-24 years old), n = 14. 13 cross-sectional surveys between 2013-15.	No changes in lifetime use after legalization. Cannabis use in Colorado higher than the national average.	
Kerr et al. (2017)	Oregon versus other states	Cross-sectional surveys in 2014 and 2016. Students aged 18-26. N = 10,924.	Greater increase in previous-month use in Oregon among alcohol users.	
Laqueur et al. (2020)	Uruguay (legal 2013, available 2017 through dispensaries, cultivation, registered clubs)	Student survey 2014-2018, comparison with Chile.	Greater perception of availability, no changes in risk perception, no changes in use. Recognizes that it may not reflect long-term changes.	Different model from USA, use in over-18-year-olds, limited quantities, no advertising, state control, no private companies.
Mason et al. (2016)	Washington	Survey of 238 14-year-old students followed-up between 2010 and 2012.	No increase in previous-month use.	Small sample and short period after legalization. Effect of medical cannabis legalization also assessed.
Mennis and Stahler (2020)	Colorado and Washington	National treatment database for CUD. SAMHSA, 2008-17. 12-17-year-olds.	No differences in treatment for CUD between states with and without legalization.	Higher %age of CUD treatment in Colorado and Washington prior to legalization versus other states. Then, further fall in Col. and Wash. due to changes in attitudes and risk perception.
Melchior et al. (2019)	USA	Meta-analysis: Includes 13 articles, 20 studies on medical cannabis legalization and 8 impact studies on recreational cannabis legalization.	Slight rise in use among adolescents after legalization of recreational use.	Short period of observation.
Miller et al. (2017)	Washington	Survey 2005-2015, with 2,069 students per year, average age 20 years.	Rise in previous-month use, up 2-3.5%, also more days of use. Higher among women, blacks, Hispanics. No change in other drugs.	
Parnes et al. (2018)	Colorado	Student surveys in 2013-2015, 5,241 students.	Rise in use, higher in those over 21 years, more 'try-it' behaviours, no changes in previous-month use. Encourages students from other states to go to Colorado.	Cannabis tourism, lower price after legalization. Displacement of student users from other states.
Rusby et al. (2018)	Oregon	Two cohorts of students before and after legalization, 13-15-year-olds.	Rise in use among young people already using, not in non-users.	
Sarvet et al. (2018)	USA	Review of 2,999 articles from 17 bibliographic sources.	Comparing states with and without legalization of medical cannabis, higher rates of use already existed in states where medical marijuana was legalized.	Prevalence of adolescent use did not increase in states with medical cannabis up to 2014.
Shi and Liang (2020)		Survey in 38 countries, 172,894 adolescents.	Greater liberalization of use is associated with higher use by adolescents; correlation after 5 years of legislative change.	

Table 6
Changes in use among adults

Author (year)	Place	Method	Results	Comments
Bae and Kerr (2020)	USA, comparison of states with and without recreational cannabis legalization	National survey administered in 2008 and 2018, 18-26-year-old students, 234,669 in states with legalization, 599,605 in states without legalization. Self-reports	Higher prevalence of previous-month use (OR = 1.23) and frequent use (OR = 1.18) than in non-legalized states, greater in women and those aged over 21 years age.	Greater increase after the first and second year of legalization, but more evident effect after more years of post-legalization (at 5-6 years post-legalization OR approx. 2).
Cerdá et al. (2020)	USA	National survey of drug use in the USA 2008-2016. N = 505,796. Evaluation before and after legalization. Three age groups: 12-17 years, 18-25 and over 26 years.	Increase in CUD in 12-17-year-olds from 2.18 to 2.72%, 25% more than in states without legalizing recreational use. No changes in 18-25-year-olds. In those over 26, increased frequency of previous-month use from 2.13 to 2.62%, and increase in CUD from 0.9 to 1.23%.	Highlights slight increase in use and moderate but consistent in CUD, and in 2016 (thus latest data), despite short assessment period.
Doran et al. (2021)	California	Survey of 563 young people (aged 18-29 years) in 2015, 3-year follow-up.	No changes in use, increase in women and decrease in men.	Not enough time for legalization to develop.
Everson et al. (2019)	Washington	Use survey, 2009 and 2016.	Greater increase in use with greater proximity to retail outlets. Use increased between 2009 and 2016, did not change immediately after legalization.	
Goodman et al. (2020)	USA (states with legal and illegal cannabis) and Canada	Online survey in 2018, n = 27,024, Age range 16-65 years.	In legal states 11.3% vs 7.4% of daily, 18.2% vs 11.6% of weekly and 25% vs 16.8% of monthly use.	Also, greater variety of products in legal states. Data from Canada similar to non-legal states in the USA as Canada had not yet legalized.
Goodwin et al. (2021)	USA	Cross-sectional national survey from 2004 to 2017, measuring use in adults with children.	Previous-month use in 2017: 11.9% in states with recreational cannabis legalization, 9.3% with medical cannabis and 6.1% illegal. Daily use: 4.2%, 3.2% and 2.3% respectively.	Recreational legalization increased use in adults with children at home. Effect of legalization for medicinal purposes had a more mixed effect.
Hammond et al. (2020)	USA and Canada	Online survey, age range 16-65 years, 27,169 subjects.	Non-users of cannabis: 43.5% in Canada (still illegal), 45.4% in illegal USA, 38.5% in legal USA. Daily use 8.9%, 7.4% and 11.3% respectively.	Data from the first wave of the survey aiming to assess changes over time.
Kerr et al. (2017)	Oregon	10,924 university students. Survey between 2012-2016.	Increase in cannabis use between 2012 and 2015 in all students. Greater increase in use in Oregon than in control states for those who reported alcohol use.	
Rotermann (2020)	Canada	Survey of use in 2018-2019, before and after legalization.	Use increased from 14.9% to 16.8% in the last 3 months after legalization, more in men and those aged over 25. Stable daily use at 6%.	52% obtained cannabis from legal sources, buying from illegal sources decreased from 51.7% to 40.1% in the first year of legalization.
Rotermann (2019)	Canada	Survey of use in 2018-2019, before and after legalization	Before legalization, use decreased in 15-17-year-olds, was stable in 18-24-year-olds and increased in 25-64-year-olds. After legalization, consumption increased from 14 to 18%, more in men.	Use increased but short period of implementation of legalization.
Steigerwald et al. (2020)	USA differentiating between states with and without legalization.	National survey, N=16,280, 56.3% responded (9,003).	Previous-year cannabis use 20% vs 12% in non-legal, 20% more frequent in states with legal than non-legal use.	Greater use of different varieties.

Regarding adolescent treatment admissions for cannabis use, no increase was noted in Colorado and Washington after the legalization of recreational cannabis. According to Mennis and Stahler (2020), this may be due either to the fact that cannabis use among young people has not increased, or because CUD levels have not changed despite the increase in use. The authors found changes in attitude and risk perception regarding cannabis use. Along similar lines, an assessment of the first three years of legalization in Colorado (Ghosh et al., 2017) did not find that consumption increased among young people but that the perception of risk decreased. Likewise, another study

carried out in the same state suggests that there were no differences in use (if anything, frequent use decreased) but there was a decrease in risk perception among adolescents (Brooks-Russell et al., 2019). The results obtained in Washington follow a similar pattern, with no increase in use among adolescents but a decrease in their perception of risk (Fleming et al., 2016).

3.3. Changes in adult use

Studies focusing on the effect of medical cannabis legalization in the USA indicate that use and CUD in adults have increased (Cerdá et al., 2020). Using data from

surveys conducted in the same country from 1991 to 2013 (studies by NLAES and NESARC), Hasin et al. (2017) point out that legal medical cannabis increased the prevalence of illegal use and CUD. Thus, in a national survey on drug use in the United States, Mauro et al. (2019) revealed a rise in use among both sexes in those aged over 26 years.

In any case, it is important to consider that short-term effects do not predict long-term changes (Hall et al., 2019) since such changes do not occur immediately after legalization (Everson, Dilley, Maher & Mack, 2019). Short-term changes may not anticipate changes once the market stabilizes as it takes one to two years for dispensaries to function properly after legalization and, furthermore, many states have strong markets for medicinal cannabis that can affect this process of demand (Smart & Pacula, 2019) (Table 6).

An increase in use among cancer patients has also been described after the legalization of “recreational” use (Pergam et al., 2017), in line with the lack of separation between the possible medicinal properties of cannabis and its “recreational” use. In a survey of cancer patients in Canada, just after the legalization of recreational cannabis, an increase in cannabis use was noted from 23% to 29%, but difficulties were reported in obtaining certain products only available on the illicit market and at high cost (Hawley, Gobbo & Afghari, 2020).

3.4. Changes in the demand for treatment for CUD and cannabis dependence

It has been plausibly hypothesized that rising cannabis use will cause an increase in the incidence of CUD and the demand for treatment for this reason. If this were the case, it would probably be an association that would become observable after several years. It has been noted that two years after legalization, the demand for such treatment in

Washington has decreased, but this was also in line with other states where “recreational” use had not been legalized (Hall & Lynskey, 2020). An assessment of adolescent treatment admissions (12-17 years) up to 2017 found that there were no changes in Colorado and Washington compared to other states; this can probably be explained by changes in attitude and risk perception (Mennis & Stahler, 2020). However, an analysis of such admissions between 1992 and 2016 indicates that the demand for treatment for cannabis as the main drug or concomitantly with alcohol increased among adolescents, and at a faster rate than treatment for other substances (Standeven, Scialli, Chisolm & Terplan, 2020). A review of the field indicates that greater social acceptance and lower risk perception may result in treatment not being requested (Sahlem, Tomko, Sherman, Gray & McRae-Clark, 2018). It is thus too early to draw firm conclusions regarding this aspect (Table 7).

It has been observed that after several years of medical cannabis legalization, a higher frequency of CUD was noted, especially in states permitting dispensaries and collective cultivation. The demand for CUD treatment is increasing both globally and for young people (Smart & Pacula, 2019), and a link has been established between higher density of medical cannabis dispensaries in California and CUD hospitalizations (Mair, Sumetsky, Kranich & Freisthler, 2021).

3.5. Impact on the consumption of other drugs

Another aspect of interest is whether the legalization of recreational use can influence the use of other substances by a substitution effect, by changes in the risk perception of other drugs or by concomitant use. For example, using data from a national survey in the USA from 2004-2017, Kim et al. (2021) pointed to the frequent co-use of cannabis and

Table 7
Demand for treatment of CUD and cannabis dependence

Author (year)	Place	Method	Results	Comments
Mair et al. (2021)	California	Spatial analysis of the data on discharges after admissions for cannabis use (2013-2016).	The density of medical cannabis dispensaries seems to be positively linked to hospitalizations for cannabis use disorder in the same year, but not the following year.	
Mennis and Stahler (2020)	Washington and Colorado	Admission registry SAMHSA TEDS-A for adolescents aged 12-17 years (2008/2017).	Treatment admissions for cannabis use in adolescents did not increase in Colorado and Washington after recreational legalization.	This may be due to: 1) adolescent use did not increase, 2) CUD did not increase (even if use did). 3) Demand for treatment changed due to changes in attitudes and risk perceptions towards cannabis use.
Sahlem et al. (2018)	USA	Review analysed public health results in the USA	Only 17% of cannabis users self-identify as medical users.	Medical users were more likely to use daily. They generally considered themselves less healthy and tended to be older compared to recreational users. In recent years there was a decrease in people seeking treatment for CUD.
Standeven et al. 2020	USA	Data analysis from 1996 to 2016. Shows adolescents and young adults.	Data on treatment/ admissions episodes for adolescents (12-17 years) and young adults (18-24 years) admitted for CUD treatment since 1992/2016 (N = 3,794,213).	Admissions for CUD treatment were the highest (38%) (followed by heroin and alcohol) in 2016. Being adolescent, non-Hispanic black male (with concurrent alcohol use) was associated with admission for CUD treatment compared to other substances.

Table 8
Impact on the use of other drugs

Author (year) Place	Method	Results	Comments
Alley et al. (2020) USA	Four-year cross-sectional survey 2008/2018 in colleges and universities. Sample: 18-26-year-old college students attending college in states that did and did not implement legalization in 2018.	Recreational cannabis legalization was associated with lower prevalence of binge drinking among college students aged 21 and over and increasing abuse of sedatives among minors.	Recreational cannabis legalization did not change secular trends in the use of other substances.
Doran et al. (2021) California	Survey of 563 young people (aged 18-29 years) in 2015, 3-year follow-up.	No changes in use, increase in women and decrease in men.	Not enough time for legalization to develop.
Nicksic et al. (2020) USA	2016 and 2017, national survey on tobacco in young people.	Among young people aged 19-21 cannabis use in sometime e-cigarette (EC) users increased.	Medical and recreational cannabis laws and the absence of legal minimum age for sale of EC were positively associated with cannabis in sometime EC users.
Subbaraman and Kerr (2020) USA	Cross-sectional samples between 2014 and 2016 (N = 5,492).	No significant changes observed in the overall sample in any of the measures of alcohol use between 2014-2016, but prevalence of cannabis use increased from 25% to 31.7%, prevalence of alcohol-related harm in the home decreased significantly from 2.1% to 1%, and the prevalence of alcohol-related financial harms decreased from 1.5% to 0.8%.	
Veligati et al. (2020) USA	Tax revenue in 50 states. Comparison between states with medicinal and recreational cannabis.	No statistically significant associations were found between medical or recreational cannabis legalization policies and per capita alcohol or cigarette sales.	No evidence was found of a causal association between the legalization of recreational or medical cannabis and changes in per capita alcohol or cigarette sales.

alcohol. The legalization of medical cannabis was linked to an increase in such polydrug use in people aged over 50 years, and the legalization of “recreational” cannabis was also more clearly associated with the increase in co-use of alcohol and cannabis, with an increase in cannabis use alone and a decrease in alcohol use alone also being observed.

Furthermore, in a survey conducted in 2018 among American students aged 18-26 comparing states with and without legalization, Alley, Kerr and Bae (2020) revealed a decrease in binge drinking among those over 21 years of age in states with cannabis legalization, an increase in the use of sedatives in minors and no change in the use of stimulants or opioids. Similarly, data from several surveys conducted in Washington between 2014-2016 showed an increase in cannabis use from 25% to 31.7%, but there were no changes in the year immediately after legalization regarding the concomitant use of cannabis and alcohol or total alcohol consumption, although there was an increase in concomitant use in those aged over 50 years (Subbaraman & Kerr, 2020).

At the same time, after another review of the relationship between cannabis use and alcohol in the US under current cannabis policy, Guttmanova et al. (2016) considered that there was evidence for both a substitution (cannabis substituting alcohol in states with a more liberal cannabis policy) and a complementary effect (an increase in both uses after liberalization); however, their data came from studies focused on the decriminalization of cannabis use and legalization for medicinal purposes, without data on the effects of recreational cannabis legalization.

With regard to tobacco, in a survey of 563 young people aged 18-24 in California (where cannabis has been legal since 2016) between 2015-2018, Doran, Strong, Myers, Correa and Tully (2021) observed an increase in its use and also in electronic cigarettes associated with the legalization of cannabis, but the assessment period after legalization was short. Along similar lines, Nicksic, Do and Barnes, (2020), in a survey on tobacco use in the USA, observed that the legalization of cannabis was associated with greater use of cannabis derivatives in electronic cigarettes and this form was linked to an increase in tobacco use and low risk perception regarding this use. Similarly, Wang, Ramo, Lisha and Cataldo (2016a) found that there was an increase in the concomitant use of tobacco and cannabis, especially in the youth population in the USA states where the use of cannabis was legalized for medicinal purposes.

Conversely, research such as that of Veligati et al. (2020) analyzing alcohol and tobacco sales in the USA and differentiating by states with and without recreational cannabis legalization, found no link between the sale of tobacco or alcohol. Kerr, Bae and Koval (2018) reported a decline in tobacco use in Oregon after legalization, but no effect on alcohol or other illicit drugs.

Data is therefore not consistent, and this was pointed out in a review on the uncertain impact of cannabis legalization on alcohol and tobacco use (Smart & Pacula, 2019). Regarding opioids, the same review argued that the findings of the initial study showing a positive effect of medicinal cannabis in reducing mortality from opioids, which has had a significant media impact, could not be corroborated in later studies and, likewise, that no corresponding evidence was

Table 9
Effects of legalization on use among pregnant women

Author (year)	Place	Method	Results	Comments
Barbosa-Leiker et al. (2020)	Washington	Qualitative study in 14 pregnant women and 5 postpartum.	Continuous use during pregnancy, low perception of risk. Use to manage pregnancy discomfort and anxiety as an alternative to medication.	
Castro et al. (2020)	Uruguay	Cross-sectional and analytical study. 577 pregnant women, 319 interviews conducted in 2013 and 258 in 2016.	In 2013, 5 women reported smoking marijuana (1.57%) during pregnancy, while in 2016 there were 28 (10.85%). Cannabis and alcohol use during pregnancy increased, tobacco use decreased. Cannabis use before pregnancy: 12.85% in 2013 and 30% in 2016, during pregnancy: 1.6% in 2013 and 10.85% in 2016.	
Crume et al. (2018)	Colorado (legal in 2012, first dispensary 2014)	Cross-sectional study, 3,207 responded, 2014-2015, monitoring system.	5.7% used during pregnancy and 5% when breastfeeding, higher than estimated for the USA (around 3.6%). Prenatal use was associated with low birth weight.	
Lee et al. (2020)	California	Retrospective study of 466 women between 2016 and 2018.	Increase in all types of cannabis use from 6% to 11% during pregnancy just after legalization.	
Ng et al. (2020)	Nueva Jersey	Cross-sectional survey of 1,133 pregnant women.	Most of the pregnant women surveyed showed little knowledge about the risks of cannabis during pregnancy and indicated that they would be more likely to use during pregnancy if it were legalized.	Additional research is needed to clarify the associated risks.
Skelton et al. (2020)	USA	Self-reported questionnaire. Logistic regression: sample of 7,258 women.	Greater chance of childhood exposure to cannabis in states where it is legalized.	
Whitehill et al. (2019)	Massachusetts	Longitudinal study of 218 telephone calls.	Cases of pediatric exposure to cannabis increased in Massachusetts after medical marijuana was legalized in 2012.	States that legalize should strengthen regulations to prevent unintentional exposure among children and prevent use among adolescents.
Wolf et al. (2020)	Emergency Departments USA	Qualitative exploratory (2008-2017) using data collected by focus group nurses.	Increase in patients with cyclical vomiting syndromes and greater difficulty in managing associated behaviours.	Proposal to standardize the formulation, dosage and labelling of cannabis products.
Yeung et al. (2020)	Alberta	Longitudinal study. Registry of histories.	Canadian cannabis legalization was associated with small increases in cannabis-related ED visits in urban Alberta and calls to a poison control centre.	

found with the legalization of “recreational” cannabis (Smart & Pacula, 2019). However, Kropp et al. (2020) reported a fall in the use of opioids for chronic pain in Colorado after the legalization of cannabis, but, conversely, Alcocer (2020) showed that recreational cannabis legalization did not lead to a decrease in the opioid crisis in the same state.

Regarding the impact of recreational cannabis legalization on fatal opioid overdose deaths, Chihuri and Li (2019) concluded that while a slight reduction in opioid prescription may be observed, no evidence of a decrease in mortality from overdose was found. A similar conclusion about the limited impact on opioid use was drawn by another review focused primarily on studies of medical cannabis legalization (Wendelboe et al., 2019). Therefore, not enough evidence exists yet to show that the use of other drugs changes after cannabis legalization.

3.6. Impact of legalization on the consumption of pregnant women and children's exposure to cannabis

Pregnant women make up another group at special risk of the deleterious effects of cannabis use on the foetus, so it is interesting to assess the risk perception of this group. In a survey of pregnant women who attended a health centre in New Jersey, 4.5% of them used cannabis during pregnancy and had little knowledge of the risks of use during pregnancy,

and 90% indicated that they would be more likely to use during pregnancy if it were legal (Ng, Rice, Ananth & Brandt, 2020). In general, it is observed that there is an increase in use among pregnant women, a low perception of risk for the foetus and it is seen as an alternative to alleviate pregnancy distress, which contrasts with a greater awareness of the negative effects of other drugs on pregnancy (Table 9).

At the same time, it has been shown that there is a greater likelihood of child exposure to cannabis during pregnancy in the states where it is legalized (Skelton, Hecht & Benjamin-Neelon, 2020). In Washington state, a percentage of pregnant women who used cannabis prior to gestation reported continuing to use it daily during pregnancy and postpartum to care for themselves and their baby (Barbosa-Leiker et al., 2020).

In Uruguay, between 2013 and 2016, a significant rise in self-declared cannabis use during pregnancy was observed; while 1.57% of women reported smoking cannabis in 2013, this was 10.85% in 2016. The same trend was also noted in the consumption of alcoholic drinks during pregnancy, rising from 23.8% in 2013 to 35.3% in 2016. The consumption of cocaine and cocaine base paste remained stable during this period. However, tobacco use fell significantly in the same period, although it remains the most frequently used drug by pregnant women in Uruguay, at 39.9% in 2016 (Castro et al., 2020).

4. Impact on emergency hospital admissions

With regard to emergency hospitalizations, data found by Wang, Davies, Halmo, Sass and Mistry (2018) in Colorado show a significant increase in emergency admissions for cannabis use, increasing by 1.8 per 1,000 visits in 2009 to 4.9 in 2015. Similarly, calls to Colorado's regional poison centre remained constant from 2000 to 2009; in 2010, however, after the liberalization of medical cannabis, the number of calls for cannabis exposure increased significantly from 42 to 93. In 2014, after recreational legalization, calls again rose sharply by 79.7%. The over-17 age group also made more calls after 2014 (Wang et al., 2017). In Canada, cannabis legalization was associated with slight increases in cannabis-related emergency department visits in urban Alberta and calls to the poison control centre (Yeung, Weaver, Janz, Haines-Saah & Lang, 2020).

In a study carried out in Colorado (Sokoya et al., 2018), an increase in facial trauma related to the effects of cannabis intoxication was found, although this increase was higher in older patients compared to the period prior to legalization, with fractures of the maxilla and base of the skull being the most frequent. It may in general be concluded that there is an increase in acute harm associated with high-potency cannabis in states where cannabis is legal (Matheson & Le Foll, 2020).

A further relevant aspect to investigate is the impact that cannabis legalization could have among the pediatric population, as it increases the likelihood that minors are

exposed to this substance. Thus, cases of accidental pediatric exposure to cannabis increased in Massachusetts after medical marijuana was legalized in 2012, despite the use of child-resistant packaging and warning labels (Whitehill et al., 2019). A recent review found an increase in pediatric patients with cyclic vomiting syndromes, mainly caused by the ingestion of edible cannabis products. The main reason for this is attributed to high concentrations of THC in plants grown for medicinal cannabis and the new palatability of cannabis when infused or incorporated into sweet foods, such as candies and baked goods, thus contributing to pediatric exposures being more likely and to children repeatedly going to the pediatric EDs after consuming such cannabinoids (Wolf, Perhats, Clark, Frankenberger & Moon, 2020). A review was also carried out in Colorado comparing pediatric emergencies for accidental ingestion of cannabis before and after legalization and showing a clear increase after legalization (Wang et al., 2016b).

As in almost all aspects analyzed in this section, additional research is needed (Degenhardt et al., 2013; Felson et al., 2019).

Trends in states that have legalized cannabis and presented a growing prevalence of cannabis use, coinciding at the same time with declining risk perception, should alert pediatricians; they should be prepared to tackle the management and prevention of unintentional cannabis ingestion in childhood, as well as problematic use in adolescents (Grigsby et al., 2020).

Table 10
Impact on emergency hospitalizations

Author (year)	Place	Method	Results	Comments
Auger et al. (2020)	Canada	Longitudinal study of patient registry, hospitalized children.	Legalization of cannabis in Canada did not increase the risk of short-term cannabis-related hospitalization among older girls and boys.	In children aged 10-14, legalization may have contributed to an increased risk in children under 15 years of age.
Roberts (2019)	Colorado	Longitudinal study.	Important health consequences of cannabis legalization, especially in emergency departments and hospitals.	The most worrying: psychosis, suicide and abuse of other substances. Increase in fatal vehicle collisions, adverse effects on cardiovascular/ pulmonary systems, accidental pediatric exposure.
Rylander et al. (2014)	Colorado	Mixed regression model. Generalized linear modelling techniques (longitudinal).	Medical cannabis legalization may not have an adverse impact on suicide rates.	However, this conclusion must be examined in light of the study's limitations and may not be generalizable to people with severe mental illness.
Grigsby et al. (2020)	USA	Review (2008-2017).	The rising prevalence of children with cannabis use coincides with decreasing risk perceptions of harm from cannabis products.	Pediatricians must be ready to address the management and prevention of unintentional ingestion during childhood.
Sokoya et al. (2018)	Colorado	Retrospective review.	Maxillary and skull base fractures increased significantly after legalization.	No significant differences were observed in the proportion of patients living in urban and rural counties before and after legalization.
Wang et al. (2017)	Colorado	Registry 2009/2015.	Review of pediatric emergencies for accidental cannabis ingestion before and after legalization in Colorado (increased after legalization).	

5. Repercussions of legalization on psychiatric emergencies

Research in Colorado shows that cannabis legalization has seen significant increases in cases of psychosis, suicide, and other substance abuse (Roberts, 2019). In this state, ED presentations for mental illness with a cannabis-related code increased five times faster than visits for mental illnesses without such a code between 2012 and 2014 (Wang et al., 2017). The largest increases involved persons diagnosed with schizophrenia and other psychotic disorders, suicide, intentional self-harm, and mood disorders (Hall et al., 2018). Thus, in 10 of the 13 prospective longitudinal studies carried out, it was found that users of cannabis have a significantly higher risk of psychosis compared to those who do not (Murray & Hall, 2020).

Regarding anxiety disorder, in USA states where cannabis has been legalized, use has increased among adults in general, but this increase was disproportionate among the population diagnosed with anxiety (Weinberger et al., 2020). There does not appear to be an association between higher anxiety and patterns of cannabis use in USA states with legalized medical marijuana, with cannabis use being more frequent in these states (McBain et al., 2020).

6. Repercussions of legalization on traffic accidents

With regard to traffic accidents, the deleterious effects of cannabis on the brain include reduced complex decision-

making capacity, which may not be reversible with abstinence and which could be linked to an increase in accident rates and road traffic mortality and, therefore, to increased hospital emergency service activity. Such increases in emergencies due to motor vehicle collisions have been documented after legalization (Roberts, 2019). In the USA, a slight increase in fatal traffic accidents was seen in states where recreational cannabis is legal (Lane & Hall, 2019). THC positivity among driver deaths has increased since legalization in various USA states, at a three times higher rate from 1993-2000 to 2001-2015. THC-positive traffic fatalities were more frequent among young people and more likely in single-vehicle crashes, night-time crashes and speeding; moreover, victims were less likely to have worn a seat belt or helmet (Steinemann et al., 2018). The state of Colorado recorded an increase in the trend of all fatal accidents after recreational cannabis legalization and the start of over-the-counter sales. While traffic fatalities increased, deaths of pedestrians being hit by cars did not, however (Calvert & Erickson, 2020).

At the same time, in the year following the implementation of recreational cannabis sales, traffic fatalities increased by an average of one additional death per million residents in states where recreational cannabis had been legalized, i.e., Colorado, Washington and Oregon and its neighbouring jurisdictions (Lane & Hall, 2019).

In Uruguay, 2013 legislation legalizing recreational cannabis use may be associated with an increase in fatal

Table 11
Impact on traffic accidents

Author (year)	Place	Method	Results	Comments
Calvert and Erickson (2020)	Colorado (2012)	Longitudinal. Registry of histories.	Increasing trend in all fatal crashes after recreational cannabis legalization. No link to pedestrian deaths.	
Eichelberger (2019)	Washington	Self-reported longitudinal study of 2,355 drivers (2014/2015).	The proportion daytime drivers with positive THC increased from 8% before retail sales to 23% 6 months after retail sales; no change in the proportion among night drivers (19% and 20%).	
Goodman et al. (2020)	Canada and USA	Cross-sectional survey.	In legal states, high-THC products were significantly more likely to be used than in illegal USA states or Canada, and users were more likely to drive after cannabis use than users in Canada ($p < .001$ for all).	
Keric et al. (2018)	USA	Longitudinal study (2008-2017). Survey of 127 participating trauma surgeons.	Variation between states studied in prevalence of cannabis and alcohol. The impact of marijuana decriminalization did not appear to affect the incidence of driving while high on marijuana.	
Lane and Hall (2019)	Colorado Washington and Oregon	Registry. 2009-2016.	Slight increase (+ 1/million inhabitants) in fatal traffic accidents in legal states.	
Nazif-Muñoz et al. (2020)	Uruguay	Uninterrupted time series analysis. January 1, 2012 to December 31, 2017.	Increase in traffic accidents (light vehicles) in Uruguay after legalization.	
Salomonsen-Sautel et al. (2014)	Colorado	Comparativa 1994-2009 y periodo post-legalización 2009-2011.	Increased proportion of THC-positive drivers in fatal Colorado traffic accidents pre vs post legalization, although period of time after legalization was short.	

motor vehicle crashes, particularly involving drivers of light vehicles and urban settings (Nazif-Muñoz et al., 2020).

7. Impact on the legal system:

Violence and crime

Another aspect to consider regarding legalization is the possible reduction in the number of legal cases and everything crime related, including violence. Studies show that in the states where marijuana was legalized during 2010 and 2014, there were no statistically significant differences in the rates of property crime, but violent crime, murder, aggravated assault, robbery, and theft appeared to be higher in states where marijuana was completely banned (Maier, Mannes & Koppenhofer, 2017).

Research by Dragone, Prarolo, Vanin, and Zanella (2019) provides evidence that legalization of the cannabis market in USA states has led to a drop in crime. Thus, in Washington, burglaries fell by approximately 15% to 30%, crimes by between 10% and 20%, and robberies by between 13% and 22%. Nor was an increase in crime noted in Denver or Colorado when cannabis also became available recreationally in neighbourhoods with the highest density of therapeutic cannabis dispensaries (Freisthler, Gaidus, Tam, Ponicki & Gruenewald, 2017). It is still unknown whether the legalization of recreational cannabis has affected the variations detected in crimes, and if so, how. It will still take some time for data that may clarify these issues to become available, although the most recent studies have not found any associations between changes in legalization and the increase or decrease in crime (Maier et al., 2017). However, certain meta-analyses have shown that cannabis use is linked to violence in high-risk populations

and those with severe mental problems, so measures should be taken to mitigate the risks (Dellazizzo, Potvin, Athanassiou & Dumais, 2020).

Rates of cannabis-related arrests among African American and white adults decreased significantly with the legalization of possession and remained at a lower rate after the retail marijuana market opened. However, relative disparities in marijuana arrest rates for African Americans increased among older adults and were unchanged for younger adults (Firth, Maher, Dilley, Darnell & Lovrich, 2019).

Minor criminal justice offenses in Washington State fell substantially after legalization, but disproportionate enforcement among racial/ethnic minorities continues (Jensen & Roussell, 2016). At the same time, it can be seen that while legalization has not reduced arrests of young people for possession, it does seem to have done so among adults (Plunk, Peglow, Harrell & Grucza, 2019).

Discussion

There is considerable heterogeneity in the legislative measures adopted by the different countries where the recreational use of cannabis has been legalized. Thus, Uruguay introduced a model with strict control by the state, without advertisements promoting cannabis use, but this less commercial model, with potentially less risk to public health, has not yet been fully implemented. To date, the measures introduced have not succeeded in completely suppressing the illicit market for this substance in the country, which is possibly due to a reluctance on the part of users to register. Conversely, the business model

Table 12
Impact on the legal system

Author (year)	Place	Method	Results	Comments
Dragone et al. (2019)	USA	Quasi-experimental design, data from US Uniform Crime Reporting for the years 2010 to 2014.	Crime fell in states with legalized recreational use, and more in neighbourhoods with more dispensaries, with disruption of the illegal market being the most plausible explanation.	Four possible causes of this decrease in crime are established.
Dellazizzo et al. (2020)	Various countries	Meta-analysis.	Evidence-based research from meta-analyses has shown that cannabis use is associated with violence; measures must be taken to mitigate risks.	
Firth et al. (2019)	Washington	Longitudinal registry study. National Reporting System Based on Incidents 2012-2015.	Arrest rates among African American (2.5) and white (5) adults fell after legalization and remained at a lower rate after the market opened.	However, the relative disparities in cannabis arrest rates for African Americans increased for those of legal age. No changes in younger adults.
Jensen y Roussell (2016)	Washington	Longitudinal registry	Minor cannabis-related offenses with criminal justice system involvement were substantially reduced, but disproportionate enforcement of racial/ ethnic minorities continues.	
Maier et al. (2017)	USA	Uniform Crime Report (UCR) from 2010-2014 comparing 50 US states with and without legalization.	Results indicated the trend for violent and property crime rates was rising in states where cannabis was still illegal; the difference was not significant.	Even when controlling for factors that can lead to crime, the legal status of cannabis in the states failed to predict property or violent crime rates in 2014.
Plunk et al. (2019)	USA (2008/2017)	Record of arrests: January 1, 2000 to December 31, 2016.	Legalization led to reduced arrests for possession in adults but not in young people.	

implemented in many USA states has given rise to strong commercial interests and aggressive marketing strategies that may contribute to greater cannabis use and lower risk perception. Despite this, these models have not managed to eliminate the black market either, but rather to reduce prices because of stronger competition and thus greater availability. Canada, with stronger advertising limits, represents an intermediate level of control regarding the sale of cannabis compared to the other two countries, yet similarly, it is recognized that the illicit market still plays an important role. The aim of suppressing this market and protecting the most vulnerable, such as adolescents, have therefore not been achieved to date.

The legalization of cannabis markets has substantially reduced the price of cannabis and increased its potency, and prices are likely to continue declining if legalization becomes federal policy in the USA, especially if imports and home delivery are permitted (Kilmer & Neel, 2020). As for the prices of illicit cannabis in both Canada and the United States, these are lower than for cannabis sold in official dispensaries, which is why many users, especially minors continue to resort to the illicit market for their supplies (Rehm & Manthey, 2020).

Regarding the relationship between price and potency, governments of states authorizing the retail sale of cannabis have not taxed cannabis products based on their potency, as is the case with alcohol (Hall & Lynskey, 2020). Currently, no USA jurisdiction has raised cannabis taxes high enough to prevent falling prices after legalization, with tax rates ranging from 10% in states like Colorado or Nevada to 37% in Washington (Davis, Hill & Phillips, 2019). It should be noted that in both the USA and Canada, the dispensing of products with high concentrations of THC at low prices puts consumers at greater risk of developing both CUD and psychotic disorders. Although only a minority develop a psychotic disorder, those consuming cannabis with over 10% THC daily are five times more likely to develop a psychotic disorder than those who have never used it (Di Forti, 2020). In the USA, this increase in THC content in legalized states has not been matched by greater access to accurate information about the potency of products accessible to consumers; the opposite has rather been the case as the industry tends to avoid contemplation of the drawbacks and risks of cannabis with high concentrations of THC and low CBD (Cash et al., 2020; Chandra et al., 2019). In both the USA states that have legalized cannabis and in Canada and Uruguay, there is an inherent tension between the political goals of minimizing taxes to reduce the illicit market for cannabis and imposing high taxes to discourage excessive use (Hall et al., 2019).

On the other hand, legalization has also generated new forms of cannabis use, highlighting products made with “hash oil” such as “dabs” and edibles, which have been associated with a higher risk of adverse effects (Grewal

& Loh, 2020), the main cause being the large amount of THC that these products contain. The risk of addiction is 20-30% higher in people who use cannabis 100 times or more, and could be higher in those who use high-potency products (Chandra et al., 2019). To address these drawbacks, Matheson and Le Foll (2020) propose three approaches to minimize these harms: Early restriction of cannabis edibles and high potency products; clear and consistent labelling stating dose/serving size and health risks; and the implementation of robust data collection frameworks to monitor harms, disaggregated by type of cannabis product (e.g., dose, potency, route of administration) and consumer characteristics (e.g., age, sex, gender, ethnicity).

Furthermore, it was to be expected that the legalization of “recreational” use would have an impact on the levels of cannabis consumption due to the effects on price, accessibility, acceptance and promotion of use. While there is evidence of a moderate increase among adults, although not adolescents, this has possibly not been higher due to the slow processes in the introduction of legislative changes and greater accessibility to the product. The importance of the accessibility factor is shown by the higher consumption evident in regions with greater proximity to dispensaries (Everson et al., 2019). According to Hall and Lynskey (2020), these moderate effects on the increase in use among adults and the smaller effect among young people may be due to the shortage of sales dispensaries in many towns and cities and the limitations in marketing due to the federal prohibition in the USA. Increases in use could be due to rises in the quantity and frequency of use among previous users or the appearance of new users.

Increasing use by pregnant women has also been detected in the three countries, as well as a decrease in risk perception regarding the effects of cannabis on the foetus (Gnofam, Allshouse, Stickrath & Metz, 2020; Lee et al., 2020). Some epidemiological studies have suggested that cannabis use during pregnancy was associated with an increased risk of being small for gestational age, preterm delivery, low birth weight, and admission to a neonatal intensive care unit (Bailey, Wood & Shah, 2020; Kharbanda et al., 2020). Despite this, in countries where cannabis has been legalized, pregnant women justify its use to treat nausea, vomiting, pain, and other symptoms (Postonogova, Xu & Moore, 2020; Takakuwa & Schears, 2019). There is a growing public health concern in the USA regarding this issue and several authors argue that pregnant women do not receive enough cannabis-related testing and counselling from health professionals (Mark & Terplan, 2017; Polen, Whitlock, Wisdom, Nygren & Bougatsos, 2010).

The effect of cannabis legalization on road traffic fatalities is another growing public health concern (Kilmer, 2017). There is increasing evidence that cannabis impairs driving ability by reducing attention, perception of speed, and motor coordination (Sewell, Poling & Sofuoglu, 2009).

Thus, in the USA states where it has been legalized, Canada and Uruguay, results suggest that legalizing the sale of cannabis for recreational use may lead to an increase in deaths from traffic accidents (Lane & Hall, 2019).

There are no conclusive data on the psychopathological repercussions of recreational cannabis legalization, partly due to the as yet short period of observation, but given the relationship between increased use and potency of cannabis and problems such as psychosis and other mental disorders, it is expected that this effect may be observed in the future.

The new models of regulation focus on creating a market economy for legal cannabis, with the purported diversion of profits from illicit markets and the reduction of prohibition-related costs. However, to reduce the risks associated with the legalization of cannabis, an approach that specifically focuses on the health and safety rights of the individual should be considered. Such an approach should promote and protect individual and social health and safety, establish strict quality control of legal cannabis products regulated on the basis of THC and CBD content, and eliminate all kinds of incentives to use, thus providing a more comprehensive, coherent, sustainable and ethical framework for legalizing the use of non-medicinal cannabis.

Trivializing language and increased use of “recreational cannabis” in public spaces can lead to a widespread underestimation of the risks of cannabis use.

Thus far, the alleged advantages of the legalization and regularization of cannabis have not produced the results expected globally since consequences in various areas continue to persist and have in some cases worsened, such as in emergency hospital admissions, traffic accidents, pediatric consequences, use during pregnancy and appearance or worsening of psychiatric conditions. However, it is considered that the ultimate consequences of legalizing recreational cannabis use cannot be fully assessed until a decade or more has passed.

Conflict of interests

The authors declare no conflict of interest with regard to the implementation of this study.

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