

Cannabis potency and contamination: a review of the literature

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ABSTRACT

Aims Increased potency and contamination of cannabis have been linked in the public domain to adverse mental health outcomes. This paper reviews the available international evidence on patterns of cannabis potency and contamination and potential associated harms, and discusses their implications for prevention and harm reduction measures. **Methods** A systematic literature search on cannabis potency and contamination was conducted. **Results** Cannabis samples tested in the United States, the Netherlands, United Kingdom and Italy have shown increases in potency over the last 10 years. Some countries have not shown significant increases in potency, while other countries have not monitored potency over time. While there are some grounds to be concerned about potential contaminants in cannabis, there has been no systematic monitoring. **Conclusion** Increased potency has been observed in some countries, but there is enormous variation between samples, meaning that cannabis users may be exposed to greater variation in a single year than over years or decades. Claims made in the public domain about a 20- or 30-fold increase in cannabis potency and about the adverse mental health effects of cannabis contamination are not supported currently by the evidence. Systematic scientific testing of cannabis is needed to monitor current and ongoing trends in cannabis potency, and to determine whether cannabis is contaminated. Additionally, more research is needed to determine whether increased potency and contamination translates to harm for users, who need to be provided with accurate and credible information to prevent and reduce harms associated with cannabis use.

Keywords Cannabis, contamination, marijuana, potency.

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INTRODUCTION

Recently, there has been a resurgence of interest in cannabis. This has been evident in political and media focus on links between cannabis and mental health, and claims that cannabis, particularly the variety known as 'skunk', is much more potent than thought previously. The occurrence of mental health problems among cannabis users and evidence of increases in treatment-seeking for cannabis-related problems [1,2] have been linked to purported increases in cannabis potency [2] and contamination of cannabis [3]. The alleged increase in potency, claimed to be 20–30-fold (e.g. [4–6]), has been used to justify calls for tougher laws [7].

The 2006 World Drug Report [2] stated that increased potency means that: '... today, the characteristics of

cannabis are no longer that different from those of other plant-based drugs such as cocaine and heroin' ([2], p. 2). Recently, an Australian Government Minister expressed concerns that: 'there is evidence that hydroponically grown cannabis can contain higher levels of toxins and therefore can greatly exacerbate the onset of conditions like schizophrenia . . .' [3].

These issues are not new, with claims about escalating cannabis potency made as far back as 1975 [8]; yet we know little about cannabis markets that can help support or reject recent claims. Provision of quality information about harms associated with highly potent or contaminated cannabis has important public health implications. For example, evidence shows that ecstasy users would avoid using ecstasy that is known to contain substances other than 3,4-methylenedioxyamphetamine

(MDMA) if they were provided with that information [9]. Given the popularity of cannabis it is important we have current, accurate information on the available product, to assist users in making informed decisions about their use, and contribute to evidence-based policy development and media debate about the probable harms associated with cannabis use.

This paper reviews the available international evidence on patterns of cannabis potency and contamination and potential associated harms, and discusses their implications for prevention and harm reduction measures.

METHOD

Scientific databases (e.g. Medline, EMBASE, Psycinfo, Drug, Pubmed, CINCH, Scifinder Scholar, TOXLINE and Commonwealth Agricultural Bureau Abstracts and Biological Abstracts) were searched for papers on cannabis potency and contamination using the terms 'cannabis', 'potency', 'contamination' and related search terms (free text and expanded subject headings). Additional references were obtained from bibliographies and researchers in the field.

'Grey literature' [10] was used to supplement the limited published scientific literature. Information was also gathered from cannabis and drug policy internet sites and illicit or 'folk' literature on cannabis. This enabled the inclusion of up-to-date information to enhance our picture of the current situation [11].

CANNABIS POTENCY

What determines cannabis potency?

The psychoactive drug cannabis comes from the plant belonging to the family *Cannabaceae*, the genus *Cannabis* and the species *Cannabis sativa* and its variants, although there is some debate about species differentiation [12,13]. Most commonly, the flowering tops ('buds') or leaves are dried to prepare 'marijuana', or the resin secreted from the plant is compressed to prepare 'hash'. Less commonly, 'hash oil' is prepared by extracting the psychoactive component of the plant in oil [14]. This section discusses predominantly marijuana, as most potency research assesses this form of cannabis.

The plant contains almost 500 compounds [15], including 70 cannabinoids, which provide the psychoactive effect [16,17]. The cannabinoid with the strongest psychoactive effect is delta-9-tetrahydrocannabinol (THC). While the THC content is used commonly as a measure of potency, the psychoactive effect may also depend on levels of other cannabinoids, which may interact with each other to have either additive or antagonistic

effects [18–20]. For example, cannabidiol (CBD) acts as an antagonist for some of the effects of THC [18] and may have anxiolytic and antipsychotic effects [19]—thus, CBD may offset some of the psychoactive effects of THC, thereby affecting the potency of cannabis [20].

A major factor in determining potency is plant variety. For example, 'hemp', grown primarily for use as a fibre, contains very low THC levels and higher CBD levels compared with cannabis that is grown for its psychoactive effects [21], and variations in cannabinoid content occur depending on the plant's geographical origin [22]. Cross-breeding and genetic modification have produced hybrid subspecies with high levels of THC [23,24]. These hybrids are often produced in the Netherlands, and the seeds are available widely over the internet.

The THC content also varies according to the following factors: the part of the plant that is used, with the buds containing the most THC, followed by leaves, stems and seeds; the way it is prepared for administration, with hash oil containing the most THC, followed by hash and marijuana; storage, as THC degrades over time, particularly when cannabis is not stored in an airtight container; and cultivation techniques, such as growing female plants in isolation so they are seedless ('sinsemilla') [14,17,23,25,26]. Hydroponic or other methods of growing cannabis indoors under artificial conditions is thought to produce higher concentrations of THC than cannabis that is grown naturally, particularly in colder climates such as northern Europe [23,27]; however, this assertion is debated, and Australian research assessing this question has not been released by the funding body. The effect of indoor cultivation on potency is discussed in further detail below.

Trends in cannabis potency

Nine studies have analysed the potency of marijuana or hash over time in nine countries (Table 1). In the United States, the THC concentration of confiscated marijuana rose from 2.0% in 1980 to 4.5% in 1997 [28], and reached 8.5% by 2006 [29]. The potency of New Zealand marijuana seized between 1976 and 1996 did not show an increase [27]. A recent European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) report concluded that the potency of cannabis used in Europe has not increased significantly over time, with the exception of the Netherlands, where most of the marijuana is now produced domestically indoors [21].

Recent Dutch data indicate that the THC content of marijuana sold in 'coffee shops'—businesses that are permitted to sell small amounts of cannabis to the public—more than doubled between 2000 and 2004, but has since dropped off [30,31]. A similar pattern was observed for Dutch hash [30,31]. The marijuana samples analysed

Table 1 Summary of studies assessing the potency of marijuana.

Study	Main findings				Test	Type of cannabis (% of all samples)	Sampling (n)	Country (time period)	Comments
	Average cannabinoid level	Range—%THC	THC	Range—%THC					
ElSohly et al. [28]	THC Avg. all samples: 2.0% (1980)–4.5% (1997) CBD <1 for marijuana and sinsemilla; 1.0% (1980)– 2.1% (1997) for ditchweed CBC and CBN <1 for all samples	All years: Marijuana: 0–29.86% Sinsemilla: 0.1–33.12% Ditchweed: 0.01–2.40%	THC Avg. all samples: 2.0% (1980)–4.5% (1997) CBD <1 for marijuana and sinsemilla; 1.0% (1980)– 2.1% (1997) for ditchweed CBC and CBN <1 for all samples	Unclear what proportion of marijuana is made up of buds, versus less potent stems, leaves and seeds, and whether this has changed over time Unknown whether the samples grown indoors or outdoors	THC, CBD, CBC, CBN content	Marijuana (91%) Sinsemilla (4%) Ditchweed (6%)	Seizures (35 213)	USA (1980–97)	
ONDCP [29]	~4.0% (1983)–8.5% (2006)	Not reported	~4.0% (1983)–8.5% (2006)	Not stated whether the seizures included cannabis resin as well as marijuana, sinsemilla and ditchweed Unknown whether the samples were grown indoors or outdoors	THC content	Not reported	Seizures (59 369)	USA (1983–2006)	
Poulsen and Sutherland [27]	Leaf: 1.6% (1978–82)–1.0% (1994–96) Flowering tops: 3.8% (1976–82)–3.4 (1994–96)	Leaf: 1978–82: 0.3–4.2% 1987–89: 0.3–3.9% 1994–96: 0.2–3.8% Flowering tops: 1978–82: 1.3–9.7% 1987–89: 0.7–9.2% 1994–96: 1.0–8.8%	Leaf: (1978–82)–1.0% (1994–96) Flowering tops: 3.8% (1976–82)–3.4 (1994–96)	Leaf and flowering tops were separated for analysis and may have been from same seizure Almost all samples grown outdoors	THC content	Cannabis leaf (57.5%) Flowering tops (42.5%)	Seizures (1066)	New Zealand (1976–96)	
EMCDDA [21]	~2% (1997)–~2% (2003)	Not reported	~2% (1997)–~2% (2003)	Unknown whether samples grown indoors or outdoors	THC content	Herbal cannabis (100%)	Seizures (2268)	Austria (1997–2003)	
	~2% (1997)–~6% (2003)	Not reported	~2% (1997)–~6% (2003)	Unknown whether samples grown indoors or outdoors	THC content	Herbal cannabis (100%)	Not reported	Czech Republic (1997–2003)	
	~5% (1997)–~8% (2003)	Not reported	~5% (1997)–~8% (2003)	Unknown whether samples grown indoors or outdoors	THC content	Herbal cannabis (100%)	Seizures (17 403)	Germany (1997–2003)	

	Netherlands (1999/2000– 2001/2002)	Coffee shops (523)	Imported herbal cannabis (28%) Sinsemilla (72%)	THC content	Imported herbal cannabis: ~5% (1999/2000)–~5% (2001–02) Sinsemilla: ~8% (1999/2000)–~13% (2001–02) ~1% (1997)–~1% (2003)	Not reported	The majority of sinsemilla grown indoors
	Portugal (1997–2003)	Seizures (149)	Herbal cannabis (100%)	THC content		Not reported	Only large seizures (over 10 kg) analysed. Very small numbers in later years (e.g. 2003 average based on only 4 seizures) Unknown whether samples grown indoors or outdoors
Niesink <i>et al.</i> [31]	Netherlands (2000/2001– 2006/2007)	Coffee shops (562)	Imported herbal cannabis (26%) Nederwiet (sinsemilla) (74%)	THC content; median CBD and CBN content; CBN/THC ratio	THC Imported herbal cannabis: 5.0% (2000/2001)–7.0% (2003/2004)–6.0% (2006/2007) Nederwiet: 11.3% (2000/2001)–20.4% (2003/2004)–16.0% (2006–07) CBD and CBN <1% for all herbal cannabis samples CBN/THC ratio (×100) Imported herbal cannabis: 9.5 Nederwiet: 0.0	2006/2007: Imported herbal cannabis: 0.6–14.6% Nederwiet: 3.8–23.7%	Samples of nederwiet were chosen based on the most popular varieties sold in coffee shops at the time The most popular variety did not differ in %THC from the varieties that were supposed to be the 'strongest' Most nederwiet grown indoors
Baker <i>et al.</i> [32,33]	UK (1975–81)	Seizures (335)	Herbal cannabis (100%)	THC content	3.4% (1975)–4.9% (1981) Nederwiet: 0.0	1975: 0.2–17.0% 1976: 0.4–17.0% 1978: 0.4–8.8% 1979: 1.2–11.0% 1980: 0.6–12.0% 1981: 1.8–12.0%	All seizures were imported Unknown whether samples grown indoors or outdoors
Eaton <i>et al.</i> [34]	UK (1998–2004)	Not reported	'Cannabis leaves'	THC content	7.9% (1998)–12.7% (2004)	Not reported	Not clear what constitutes 'cannabis leaves' Unknown whether samples grown indoors or outdoors

Table 1 Cont.

Study	Country (time period)	Sampling (n)	Type of cannabis (% of all samples)	Test	Main findings		Comments
					Average cannabinoid level	Range—%THC	
Licata <i>et al.</i> [35]	Italy (1997–2004)	Seizures (947)	Loose marijuana (5%) Kilobricks (5.5%) Buds (26%) Home produced (15%)	THC content	2.5% (1997)–15.0% (2004)	Not reported	Most of the rise in potency occurred when samples of flowering tops replaced 'kilobricks' (made of stems, seeds, leaves and buds) as the type of cannabis most often seized Unknown whether samples grown indoors or outdoors

THC = delta-9-tetrahydrocannabinol; CBD = cannabidiol; CBC = cannabichromene; CBN = cannabinol. 'Marijuana' refers to a mixture of leaves, stems, seeds and buds; 'sinsemilla' refers to the female flowering tops or buds of the plant that have no seeds (have not been pollinated); 'ditchweed' refers to the fibre-type cannabis grown in the wild; 'herbal cannabis' refers to leaves and flowering tops, but not stalks, roots or seeds; 'nederwiet' refers to marijuana that is grown domestically indoors in the Netherlands and is made up of sinsemilla; 'cannabis leaves' is not defined by the study; 'loose cannabis' refers to samples with no definite form; 'kilobricks' refer to samples of pressed cannabis made up of leaves, buds, stems and seeds; 'buds' refer to the flowering tops of the plant. ONDCP: Office of National Drug Control Policy; EMCDDA: European Monitoring Centre for Drugs and Drug Addiction.

were sinsemilla, and thus unlike samples from other countries, which are usually sourced from police seizures, and contain a mixture of sinsemilla and leaf, buds, stems and seeds [31].

In the United Kingdom, the average potency of marijuana varied between 3% and 5% from 1975 to 1989 [21,32,33] and then rose from 8% in 1998 to 13% in 2004 [34]. The potency of hash in the United Kingdom fluctuated during this period, with no discernable trend. A recent Italian study found that the average potency of marijuana seizures increased from 2.5% in 1997 to 15% in 2004 [35]. Most of this increase occurred between 2000 and 2004. During this time there was an increase in the proportion of the seizures that were buds. It is likely that this shift to samples comprising the more potent part of the plant accounts for the potency increase.

Methodological issues

Several methodological issues create difficulties in drawing conclusions about cannabis potency trends. The sample sizes of cannabis products analysed are often small [35] and may not be representative of the cannabis available to users [20]. It has been argued that the potency of marijuana analysed in the United States in the 1970s was underestimated because the samples were not stored properly [36]. However, these explanations cannot account for the rise in US marijuana potency over the last decade. There is wide variation in the potency of different parts of the plant, and it is not always clear which parts have been analysed [29]. The accuracy and precision of potency analyses varies from study to study [21]. Sample selection can also affect the results of analyses: in the Netherlands, coffee shop owners were asked for the most popular samples at the time [31,37], so it remains possible that increases in the potency of domestically produced Dutch marijuana actually reflect changes in consumer preference rather than a potency increase.

Indoor versus outdoor growing: impact on potency

The popularity of growing cannabis indoors has been proposed as one of the main reasons for an increase in potency. The ability to control the environment indoors means that plants can reach their full 'potential', which includes reaching the maximum possible level of THC for the variety being grown. Is there any evidence for a change in cannabis cultivation techniques over time?

Most of the cannabis consumed in Australia is produced domestically. For the last 10–15 years, the proportion of cannabis detected by law enforcement that is grown indoors versus outdoors has increased [38,39]. This move from outdoor to indoor crops has been observed in North American [40] and European [41,42] countries.

Indoor cultivation involves controlling factors such as light, humidity and temperature [42]. The popularity of this method is due probably to the increased yield of plants grown indoors and to the fact that indoor plants can be cultivated year-round and may, under ideal circumstances, produce up to six crops per year as opposed to one (from outdoor methods of cultivation). It also ensures uniform quality due to the practice of cloning from a variety of cannabis with high THC content, and cannot be detected by law enforcement via aerial surveillance [43].

The increase in market share of indoor-grown cannabis may have led to a more consistent product in terms of potency and could, in part, explain the potency increases that have been reported in some countries, such as the Netherlands, United Kingdom and United States, although this is difficult to assess given that it is often unknown whether samples analysed have been grown indoors or outdoors.

Cannabis potency and health effects

Australian and international drug treatment and hospital data suggest that demand for treatment for cannabis-related problems is rising [1]. Cannabis has the potential to have adverse physical, psychological and social outcomes [44–46]. It has been claimed that more potent cannabis increases the risk of cannabis-related harms [17,47]. However, given the antipsychotic and anti-anxiety effects of CBD, it may be that the percentage of CBD is as important in contributing to such a risk as the percentage of THC [48]. This issue requires further research, as most studies assess only THC levels [49].

An alternative possibility is that cannabis users will titrate the amount of cannabis smoked depending on potency [50]. If users did titrate in this way, it is possible that the adverse respiratory effects of smoking would be reduced with more potent cannabis, as users would be inhaling less smoke overall. Such titration behaviour has been found for those who smoke tobacco [51,52].

Some studies have found evidence of titration behaviour (e.g. longer interval between ‘puffs’, holding smoke in lungs for shorter period of time) when smoking more potent cannabis [53–55]. However, some of these studies found that despite these behaviours, the amount of THC administered was still higher for more potent cannabis, suggesting that effective titration did not occur [55], and other studies failed to find differences in smoking behaviour for different cannabis potencies [54,56–59].

These older studies are hampered by small sample sizes ($n = 6$ to $n = 15$) and the low potency (0.2–2.1% THC) of the cannabis used. Research with larger sample sizes and higher potency cannabis seems to suggest that certain types of cannabis users may adjust the amount

they smoke, provided that they are given enough time to feel the effects of more potent cannabis. Users who are seeking the most intense high possible may be exposed to greater harms with more potent cannabis, given that they would be unlikely to adjust how much they smoke based on the potency [60].

It has been suggested that cannabis smoking behaviour is related more to learned habit rather than potency [57]. In contrast, tobacco smokers seem to be able to change the amount they smoke immediately depending on the level of nicotine in the cigarette [51,52]. Levels of nicotine may be experienced more readily by tobacco smokers than are THC levels by cannabis smokers [57].

CANNABIS CONTAMINATION

Recent Australian surveys have indicated that contamination is a concern for the general population and users of cannabis. One in four Australian adults (28%) believed that hydroponic cannabis poses a greater health risk than naturally grown cannabis due to greater potency and contamination [61]. Medicinal cannabis users avoided hydroponic cannabis because of its perceived contamination and adverse side effects [62]. Contamination of cannabis is of particular concern for medicinal cannabis users, given that the health of these users is already compromised.

However, there is a contrasting perception that cannabis is a ‘natural’ and therefore less harmful product than manufactured drugs such as amphetamines and heroin, and safer to smoke than licit cigarettes, which contain ‘chemicals’ [63].

There are three major avenues for cannabis contamination. Is there evidence to support concerns regarding contamination of cannabis?

Cultivation and storage: naturally occurring contaminants

McPartland [64] reviewed a number of studies which have found marijuana to be contaminated with fungi and bacteria. In one study, fungi was found in 13 of the 14 samples, and evidence of exposure to *Aspergillus* fungi was found in the majority of marijuana smokers (13 of 23), but only one of the 10 control participants [65]. Another study found fungal and bacterial contamination in all 24 samples, with *Aspergillus* contamination the most common [66]. Nearly half (nine of 24) of the marijuana smokers assessed had antibodies to *A. fumigatus*, and six of the patients reported respiratory complaints. A more recent study found that all seven marijuana samples were contaminated with mould, with the *Penicillium* species being the most common [67]. A Dutch study found that cannabis sold in coffee shops contained fungi and bacteria at levels unsafe for ingestion [68].

Moulds such as *A. flavus* produce mycotoxins, which can be carcinogenic [69]. *Aspergillus* can cause aspergillosis (a fatal lung disease), and studies have found an association between this disease and cannabis smoking among patients with compromised immune systems [70–73]. There is no research on whether contaminated cannabis leads to disease in otherwise healthy individuals. It has been suggested that sterilizing cannabis by heating it to 150°C for 5 minutes will kill these potentially harmful fungi spores [64].

Heavy metals present in soil may also contaminate cannabis, which has the potential to harm the user without harming the plant [22,74]. This contamination is usually restricted to specific areas with heavy metal content in soil, and thus may not represent a widespread problem [64].

Cultivation and storage: growth enhancers and pest control

Chemicals used to destroy pests are associated with risks to the individual using the pesticides as well as the consumer of the end product. Thus, there are strict government controls on pesticides that can be used commercially and domestically [75]. Because cannabis is an illegal drug, there are no equivalent guidelines or controls for cannabis cultivation, and it is not known whether certain pesticides are safe to use on a product that is smoked, even if the substance is safe for use on products that are to be ingested orally.

There is scant research on this issue. A Dutch study found traces of pesticides in cannabis, but in such small amounts that it was unlikely to cause harm to users [37]. Indoor-grown cannabis is often perceived to be more contaminated than cannabis grown naturally [61,62] because of the supposed addition of substances that maximize yield, without the observation of withholding periods or ‘flushing out’ the plant [62]. The extent to which this actually occurs cannot be determined from current literature; research has not been conducted to investigate this.

Retail: substances added for marketing purposes

Substances may also be used to ‘bulk up’ the weight of the marijuana or to make it appear more potent. Recently, there were reports of tiny glass beads added to marijuana in order to add bulk and to mimic the crystalline appearance of the resin glands, which contain large amounts of THC. This marijuana (‘grit weed’) appeared across the United Kingdom [76–78], prompting the Department of Health to issue a public health alert of potential harms associated with smoking the contaminated marijuana including sore mouth, mouth ulcers, chesty persistent coughs and tightness in the chest [79]. The Department

estimated that approximately 5–10% of marijuana seized from January to March 2007 was contaminated with glass beads [80]. There have also been reports of marijuana containing other substances such as phencyclidine and tobacco [64], but no systematic research has addressed this.

DISCUSSION AND IMPLICATIONS

There is evidence for a doubling of potency in the United States. The Netherlands recorded a doubling from 2000 to 2004, but the potency has since dropped again. Increases have been reported in the United Kingdom and Italy, although the increase in Italy is due probably to changes in the part of the plant that was sampled. No significant increase has been reported in New Zealand or in European countries other than the United Kingdom and the Netherlands.

There is enormous variation in potency, within a given year, from sample to sample. For example, in 1979 samples analysed in the United Kingdom ranged from 0.2% THC to 17% THC [32]. Thus, cannabis users may be exposed to greater variation of cannabis potency in a single year (due to this natural variation in cannabis products) than over years or decades [21].

Given the potential for other cannabinoids to offset the effects of THC, it is important to analyse percentages of other cannabinoids, particularly cannabidiol, in addition to THC [20]. The studies that did report on the percentage of cannabidiol found very low levels compared to THC [28,31], suggesting that the anxiolytic and antipsychotic effects of cannabidiol would be unlikely to offset effects of THC.

The increase of indoor-grown cannabis is often claimed to be the main factor behind potency increase [81,82], but few studies report on the cultivation technique used. High-potency cannabis existed before the advent of indoor methods of cultivation; samples of cannabis with THC content of 17% were reported in the 1970s [32]. While growing cannabis indoors probably does not in itself cause plants to be more potent, it provides controllable conditions enabling plants to be grown to their full potential so it may, indirectly, contribute to potency increases seen in some countries.

There is a perception that cannabis—particularly cannabis grown indoors—is contaminated with pesticides and other substances added during cultivation. There is evidence for naturally occurring contaminants such as fungi, which have the potential to cause lung disease among immunocompromised individuals, and possibly respiratory problems in otherwise healthy individuals. Given that cannabis is a commercial crop, it is likely that pesticides and other substances are added to maximize yield and quality of the cannabis plant. Research is

needed to determine *how* these products are used—are pesticides ‘flushed out’ of the plants appropriately and, if not, what harms are associated with smoking a product with traces of pesticides still present?

Concerns about increasing cannabis potency are based largely on beliefs that more potent cannabis causes greater harm. However, it may be that cannabis users adjust how much they use depending on potency. The evidence supporting this hypothesis is mixed. Early laboratory-based studies in general do not show evidence of titration, but these studies are small and generally compare cannabis with little variation in potency. More recent studies have reported that certain types of users may adjust the amount of cannabis smoked depending on potency.

This leaves open the question of whether more potent cannabis has contributed to increased treatment seeking for cannabis-related problems over recent years. As suggested by Hall & Swift [24], it is possible that this may be due to an increase in the use of the more potent parts of the plant, rather than an increase in the potency of the plant itself. Another reason for increase in treatment seeking could be the introduction of cannabis diversion programmes, some of which involve mandatory treatment for those who have committed a cannabis-related offence. We could also be seeing the impact of the cohort of people who began using cannabis at an early age in the 1990s, who are now presenting to treatment with problems related to their early initiation and duration of cannabis use [83].

Realistic and accurate information about cannabis potency and contamination and the associated harms are important components of any public health strategy to prevent and reduce cannabis use and related problems, and can contribute to evaluations of the impact of drug strategies. It is unclear whether informing cannabis users of contamination issues would lead to changes in behaviour, although for other drugs there is some evidence that information about quality would affect users’ drug-taking behaviour [9].

CONCLUSION

Overall, evidence for cannabis potency and contamination is fragmented and fraught with methodological problems. However, it is clear that claims of a 20- or 30-fold increase in cannabis potency and the adverse mental health effects of cannabis contamination are not supported by the evidence. Systematic scientific testing of cannabis available today is needed urgently to monitor current and ongoing trends in cannabis potency, and to determine whether cannabis is contaminated. Additionally, more research is needed to determine whether increased potency and contamination translates to harm

for users, who need to be provided with accurate and credible information to prevent and reduce harms associated with cannabis use.

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