

IV. IMPACT

Potency

It is clear that a large number of people in various countries have worked very hard over the course of decades to produce more potent cannabis. But it is still being debated whether their work has had any impact on the potency of the global cannabis supply. As early as 1980, claims were made that cannabis potency had increased by a factor of 10 (from 0.2 to 2 per cent) over a period of five years ([205], p. 12). There have been subsequent claims that cannabis potency has increased by a factor of 30 or even 60 since the 1970s. These claims have been criticized as exaggerated as they rely on the very low THC levels found in some early tests, which may have been inaccurate owing to storage problems and other methodological difficulties.

Claims of extreme increases in potency have cast doubt on the general argument that cannabis today is different than cannabis was in the past. This is unfortunate, because there can be little doubt that cannabis has changed, and that it is possible to mass produce cannabis today of a potency level that would have been unimaginable just 25 years ago. The real question is what share of the market this high-potency cannabis presently commands. Two data sources have been advanced to answer this question. One is the average potency figures from scientific testing and the other is survey data from users on which forms of cannabis they consume. The former suffers from a lack of randomness in the selection of samples tested and other methodological difficulties, and the latter suffers from the limited ability of users to distinguish accurately high-potency and low-potency forms of the drug.

The potency debate has generally hinged on measurements from police forensic testing. This information is collected for other purposes, not to create internationally comparable, time-series data. There is really no systematic programme monitoring cannabis potency levels anywhere in the world. Probably the closest is the United States Marijuana Potency Monitoring Project, but this programme does not involve a random sampling of the cannabis available in the country.* From this core problem are derived several others, relating to terminology, sampling and more technical aspects of testing.

*The Marijuana Potency Monitoring Project in the United States analyses only samples seized under the supervision of the national (federal) Government. These may be expected to differ from those consumed by the general public, given the level at which most federal efforts are pitched, including large-scale and import interdiction. This is especially important given the data on the extent of small-scale production and social network distribution, as indicated in the survey data discussed in the opening to section II of the present review (trafficking).

First, there is no universal agreement on how the various cannabis products are defined. In some jurisdictions, no distinction is made between cannabis herb and cannabis resin and THC figures are simply aggregated. The various grades of cannabis herb are rarely captured, although some countries do distinguish between sinsemilla and other forms of cannabis herb. Differences in terminology make comparative work difficult.

Secondly, laboratories generally test THC levels when requested to do so by the police. This cannot be said to be a truly random sample of either the cannabis seized or the cannabis available in a society. Depending on enforcement priorities, the police may be more likely to seize certain types of cannabis (e.g. low potency imports at borders, rather than home-grown sinsemilla that is not sold to the general public). They may send samples about which they are especially curious, including samples connected to large seizures or expected to possess high levels of THC.

Another sampling issue relates to the parts of the plant that are tested. Laboratories generally test what they are given and most do not attempt to prepare it in such a way as to mimic the product actually used by the public. In other words, most laboratories test the THC levels of what is sold, not what is consumed. Since seeds may be included in non-sinsemilla samples, this may result in artificially low THC levels for low-grade cannabis. Even for sinsemilla, the presence of stems or other extraneous material results in a THC reading lower than that of the product that is actually consumed. In addition, there is often no attempt to weight the samples tested in terms of the size of the overall seizure made by the police. A single, high-potency cannabis cigarette could be given as much weight in aggregated national figures, for example, as a container-load of low-grade cannabis.

There are also complications related to the nature of cannabis itself. THC degrades over time, so the age of the sample and the conditions under which it was stored are highly relevant. The moisture content also varies greatly and, for this reason, samples seized on the street cannot be compared to samples taken during field eradication, unless the moisture levels are standardized.

Since different laboratories conduct THC testing for different purposes, comparing findings is difficult. Differing techniques are evident in the fact that some Western European countries where most cannabis resin comes from Morocco, such as Italy and Portugal, report dramatically different THC levels. Even within a given jurisdiction, techniques have improved over time. This makes comparing figures between countries or over time difficult.

Combining the forensic data with other information sources, however, gives good reason to believe that high-end cannabis is more potent than in the past and that this product is commanding a growing share of the market in many important consumer countries.

First, there can be little doubt that knowledge about the cultivation of cannabis plant and use of cannabis as a drug has improved since the 1960s. The medical cannabis provider in Canada, Prairie Plant Systems Inc., is able to mass produce 14 per cent THC cannabis herb. While individual samples of similar or greater potency may have been found in the past, it is highly unlikely that any cannabis producer operating 30 years ago would have been able to achieve anywhere near this performance. The sinsemilla technique, selective breeding for potency, more selective cleaning of cannabis herb, a greater understanding of ripeness, curing and storage techniques and improvements in cultivation technology have made it possible to produce a far more potent product than was possible in the past.

However, just because the technology exists does not mean that cultivators use it. In many countries, cultivators lack the knowledge, the resources and the incentive to produce better quality cannabis. The market for the low-potency product remains strong and producing higher quality requires both more work and more input costs. One of the great advantages of cannabis as a crop is that it requires little tending and so small-scale cultivators in poor areas can maintain a lucrative plot on the side without having to give up other productive activities. Even if a cannabis farmer in a developing country wanted to improve potency, he would have to find a market for the product. Local consumers may not be able to afford his produce and his international connections would be linked to established low-potency markets.

A good example is found in Morocco. The cannabis from which Moroccan cannabis resin is produced is not strong enough to be sold to Europe as cannabis herb. Tests conducted in Morocco show a THC content of 1.2 per cent for dried cannabis leaves, with the dried flowering tops averaging 2.7 per cent [54]. There are several reasons for this. The practice in Morocco of cultivating cannabis plant outdoors in an area that is awash with pollen at the end of the season means that sinsemilla cannot be grown. Given limited indoor space, most Moroccans sun-dry their harvest and the heat and light degrade the THC content. While there has long been Western influence in production of cannabis resin in Morocco (indeed, it is said that Western hippies taught the Moroccans to make “hashish”), efforts to introduce improved technology to the process have largely failed. For example, improved breeds are immediately crossed with the local plant, eroding potency. In the end, though, the Moroccans have little incentive to change. Their product dominates the well-established European market for cannabis resin for a number of reasons, the most significant being proximity and established smuggling routes.

Thus, a higher potential potency does not necessarily mean an increase in the average potency consumed by users. In order to understand the real impact of the new technology used in cultivating cannabis plant, the relative market shares of the high-end and low-end markets need to be observed over time.

The 2004 EMCDDA study on cannabis potency in Europe [10] is probably the best recent cross-national study of forensic information. The study cites estimates of the market share of four product types in Europe: imported cannabis herb, imported cannabis resin, sinsemilla and domestic resin. Most cannabis consumers prefer one product or the other (similar to the preferences of powder-cocaine and crack-cocaine users), so the herbal and resin markets should be seen as distinct, not agglomerated. Within the herbal cannabis market, data distinguishing between sinsemilla and imported cannabis were available for only three countries: Ireland, the Netherlands and the United Kingdom.

- In the Netherlands, 67 per cent of the cannabis consumed is sinsemilla, 29 per cent imported resin, 3 per cent imported cannabis herb and 1 per cent domestic resin.
- In the United Kingdom, in contrast, sinsemilla holds only 15 per cent of the total market, but it holds 50 per cent of the herbal cannabis market. In other words, imported cannabis herb also holds 15 per cent of the market and imported cannabis resin 70 per cent. Other analysts suggest that as much as half the cannabis consumed in the United Kingdom might be produced domestically. Most of this is likely to be indoor-produced sinsemilla from high-potency strains [66].
- In Ireland, herbal cannabis is also evenly split between local sinsemilla and imports, with most of the market (90 per cent) being imported cannabis resin.

Thus, for the three European countries for which sinsemilla information was available, the sinsemilla market either equalled or exceeded the herbal cannabis import market.

The EMCDDA estimates for the market share of sinsemilla in the United States are much more modest: only 5 per cent. This is surprising, because the share of cannabis cultivation operations that are located indoors in the United States has increased in recent years, from 2 per cent indoor cultivation in 1985 to 7 per cent in 2003, with the greatest change being seen between 1989 and 1992 ([206], table 4.38). According to the United States *National Drug Threat Assessment 2005*, the prevalence of sinsemilla is growing in the United States ([37], p. 41). Indeed, in a national survey of law enforcement agencies, more police officers said that indoor production of cannabis plant took place in their jurisdictions (76 per cent) than outdoor production (75 per cent), while 44 per cent reported that hydroponic production took place in their area ([37], p. 41). This does not necessarily mean that more cannabis is produced indoors than outdoors in the United States, but it does indicate that indoor production is very widespread.

In addition, Canada is playing an increasingly important role in cannabis imports to the United States, contributing 20 per cent of the cannabis imported into the United States in 2003, according to the response to the UNODC annual

reports questionnaire for 2003. Most of this imported product is grown indoors. Between 1997 and 2000, some 78 per cent of cannabis production operations detected in British Columbia, the Canadian province that produces over 40 per cent of the detected cannabis plant cultivation operations in the country and a major supplier to the United States, were indoors. The number of detected indoor operations tripled during the same time period [207]. A slightly lower share of all operations detected in the country were indoors [36]. Canadian authorities consider all the cannabis they test to be sinsemilla and average potency levels were 9.6 per cent in 2003, compared with 7.4 per cent for United States sinsemilla [122]. The trend has been towards larger and larger indoor operations, due in part to the growing involvement of organized criminal groups in production operations [124]. In January 2004, an operation was discovered inside a former brewery in Ontario that involved over 20,000 cannabis plants. Aside from what this says about the domination of sinsemilla in Canada, United States sources estimate that Canada produces about 12 per cent of the cannabis consumed in the country (about 1,000 tons per annum) ([208], p. 12). This would suggest that Canadian sinsemilla imports alone should comprise more than 8 per cent of the United States market. Add this to domestic sinsemilla production and its market share should be much higher than the EMCDDA estimate.

Other countries have also shown a growing market for indoor, sinsemilla, high-potency cannabis. In New Zealand, the number of national survey respondents who had ever used "skunk" increased from 10 per cent in 1998 to 14 per cent in 2001 ([60], p. 31). In the United Kingdom, Atha and others concluded that "skunk" was the only type of herbal cannabis to improve its market share among regular users between 1994 and 1997, up to just under 10 per cent ([35], p. 25). In Australia, after many years of winning market share from both imports and a remarkable outdoor industry [209], hydroponic production is now the most commonly detected method of cultivating cannabis ([175], p. 34). Survey data indicate that 94 per cent of Australian daily cannabis smokers, as well as 88 per cent of weekly smokers, typically smoked a more potent form of cannabis. These users consume an estimated 96 per cent of the cannabis smoked in the country [210], so the bulk of the market must cater to the high potency demand. In 2003, the authorities in Hong Kong SAR of China noted for the first time the importation of "buds" from the Netherlands (according to the response to the UNODC annual reports questionnaire).

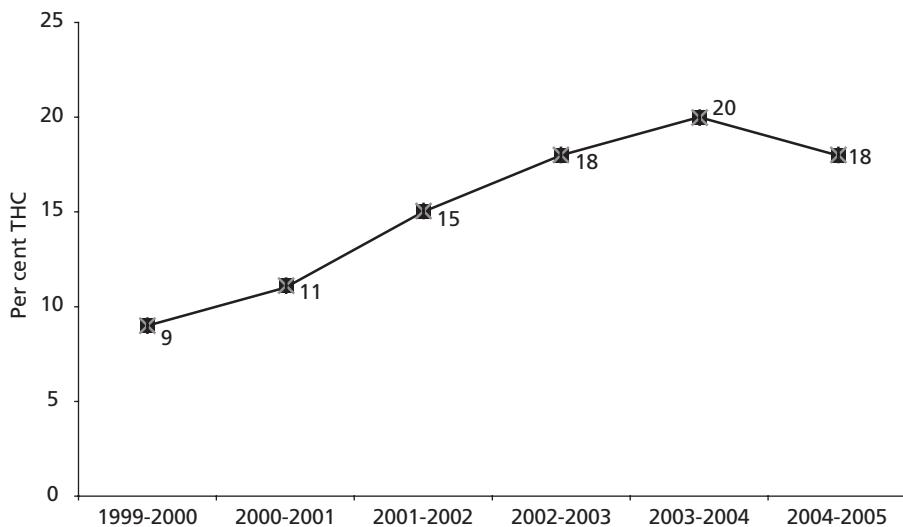
Furthermore, as discussed above, global cannabis markets appear to be becoming more limited in their reach, with consumer countries relying more and more on domestic production rather than imports. In many developed countries, this means an increase in indoor produced cannabis. In Europe, for example, the International Narcotics Control Board of the United Nations notes that "Cannabis herb is increasingly being cultivated locally, particularly in member States of the European Union" ([211], p. 72). In Spain, legal constraints on carrying, but not consuming, cannabis have led to an increase in cultivation for personal consumption since 1992 ([212], p. 649). While much of this is likely to be produced on terraces and rooftops,

those desiring potency like that of "hashish" may be compelled to grow indoors. Similarly, in Iceland, "Domestically cultivated marijuana has become increasingly competitive with imported marijuana, and current estimates indicate it makes up anywhere from 10 to 50 per cent of the total cannabis market." [149]

Thus, it would appear that the supply of high-potency cannabis is growing, although demand remains for low-quality products as well.

Within this growing share of the market, potent products appear to have been made much more potent in the last decade. The EMCDDA study and subsequent literature show quite dramatic increases in the sinsemilla potency in the United Kingdom (up from about 6 per cent in 1995 to over 12 per cent in 2002) and the Netherlands (up from about 9 per cent in 1999-2000 to about 16 per cent in 2001-2002) [10]. More recent figures from the Netherlands drawn from about 60 annual samples of the most popular strains of "nederwiet" (sinsemilla) purchased from "coffee shops" show a doubling in potency between 1999 and 2003, with levels stabilizing at about 18 per cent since that time (see figure XVIII).

Figure XVIII. Sinsemilla tetrahydrocannabinol levels in the Netherlands, 1999-2005

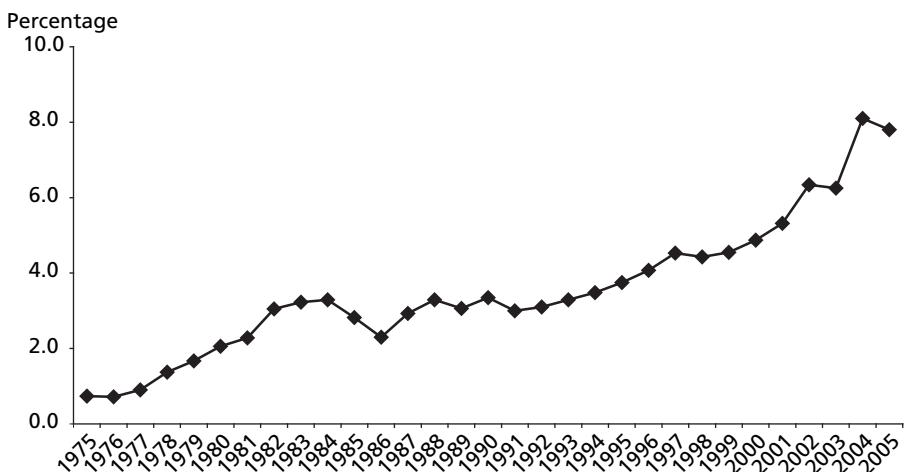


Source: Niesink, Rigter and Hoek [20].

In Germany, the European country with the largest sample base, no distinction is made between sinsemilla and low-grade cannabis. Despite this, aggregate herbal cannabis potency has clearly been going up recently. In 1996, samples averaged about 5 per cent; in 2004, they were about 11 per cent ([190], p. 44). This is very significant, as EMCDDA estimates that cannabis herb commands 40 per cent of the growing cannabis market in Germany.

In the United States, virtually all cannabis seized by the agencies of the federal Government is tested by the Marijuana Potency Monitoring Project at the University of Mississippi, which has been in place for over 20 years. The trend generally reported is an aggregated one, but it has been unmistakably upward for some time (see figure XIX).

Figure XIX. Tetrahydrocannabinol average of all cannabis samples submitted to the United States Marijuana Potency Monitoring Project, 1975-2005

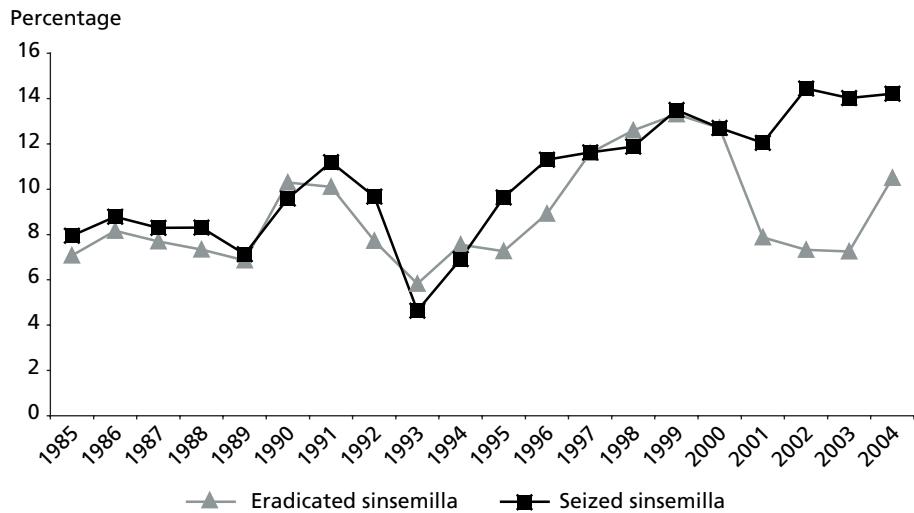


Source: United States, Marijuana Potency Monitoring Project.

Looking specifically at the sinsemilla trend, however, the general trend has also been upwards, but far from smooth (see figure XX).

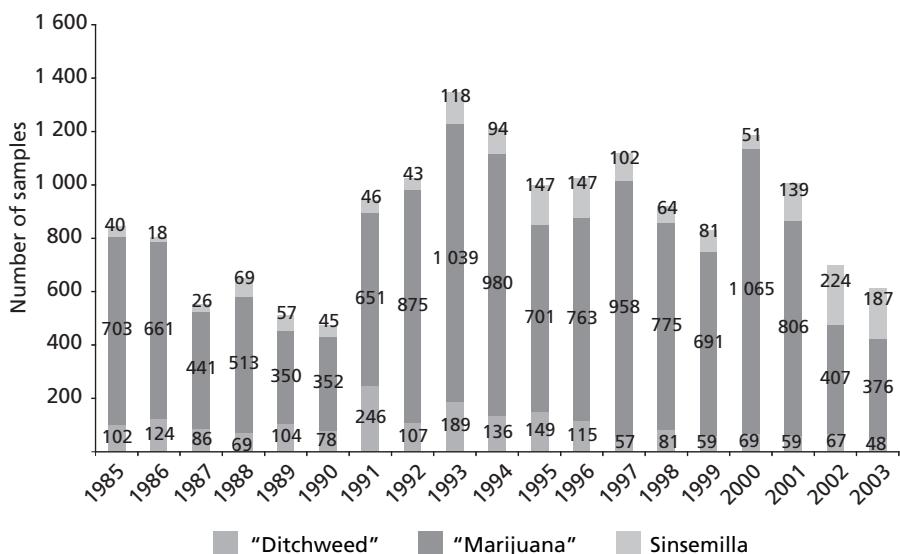
The wild fluctuations in the recorded potency levels of sinsemilla are partly a result of varying sample sizes and compositions. For example, the number of seized sinsemilla samples varied from 12 in 1985 to 5 in 1993 (a year when THC levels "dropped" precipitously) and 342 in 2003. Of course, it is impossible to speak reliably of potency levels of nationally seized sinsemilla on the basis of five samples. The inclusion of varying shares of "ditchweed" (wild cannabis), low-grade cannabis and sinsemilla in the annual sample also makes it difficult to speak of aggregate potency levels (see figure XXI). The relative market shares of these products do not vary in the way they do in the samples from the United States Marijuana Potency Monitoring Project, so it is difficult to see the sample as nationally representative. Even as a time series, the sample could be affected by changing national enforcement priorities. For example, enhanced southern border control could lead to more low-potency Mexican imports being seized, whereas a move against Asian organized criminal groups in the north-west United States could increase the indoor sample.

Figure XX. Sinsemilla tetrahydrocannabinol levels in the United States, 1985-2004



Source: United States, Marijuana Potency Monitoring Project.

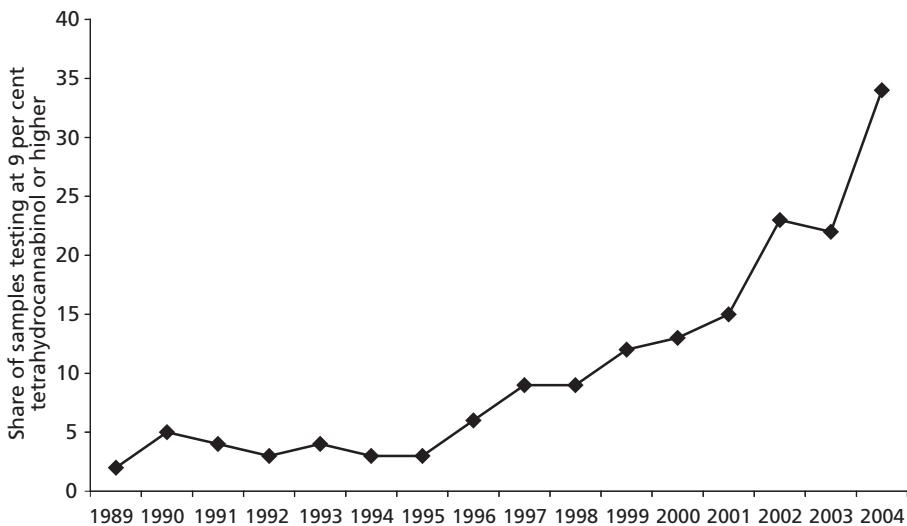
Figure XXI. Relative shares of various cannabis products in samples tested by the United States Marijuana Potency Monitoring Project, 1985-2003



Source: United States, Marijuana Potency Monitoring Project.

The underlying trend is best seen in looking at the increase in the share of all samples testing at 9 per cent THC or more (see figure XXII). Unless enforcement efforts were redirected to the higher end of the market, this trend strongly suggests an increased availability of good quality product since the mid-1990s. As in the Netherlands, the increase has been particularly pronounced since 1999.

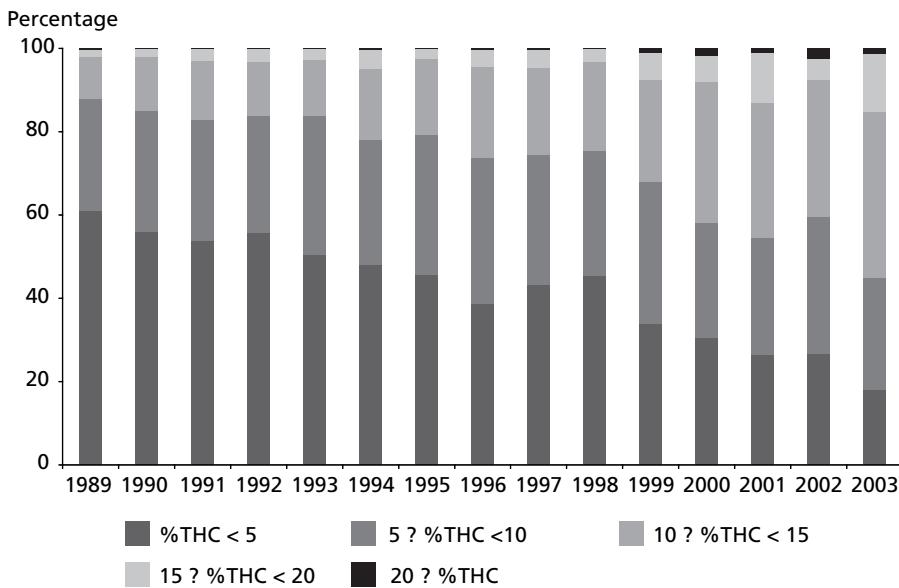
Figure XXII. Share of United States Marijuana Potency Monitoring Project samples testing at above 9 per cent tetrahydrocannabinol, 1989-2004



Source: United States, Marijuana Potency Monitoring Project.

In Canada (see figure XXIII), before the early 1980s, THC seldom reached 1 per cent, but by the late 1990s it was over 6 per cent [36]. A declining share of tested samples has less than 5 per cent THC and a growing share registers above 10 per cent. Very high-potency samples (above 20 per cent) remain relatively rare, but have certainly increased in share since 1999. These changes are partly attributed to changes in the make-up of samples admitted for analysis.

Figure XXIII. Levels of tetrahydrocannabinol in cannabis samples in Canada, 1989-2003



Source: Adapted from Viau, Marro and Walker [213].

What is the real impact of growing potency?

The existence of products with higher THC levels and the growth of the high-potency market do not inevitably mean that more THC is being ingested. It is worth noting that the winners of the annual “cannabis competitions” are not necessarily the most potent products; cannabis users appear to prefer certain strains for reasons more difficult to quantify than THC levels. This is clear in the preference for herbal cannabis in many markets, over the (generally) more potent cannabis resin. If, as the EMCDDA study suggests, price varies linearly with potency, users may prefer to smoke twice as much of a strain half as strong to achieve the desired effect, while others may seek to reduce the negative effects of smoking by utilizing high-grade product. Prices are relatively low in the cannabis market and, unlike some other drugs, cannabis use does not produce the kind of dependency that requires a set amount of the drug to be consumed each day in order for the user to function. This allows consumers to be somewhat indulgent in their smoking habits and brand preferences.

On the other hand, higher potency products, especially if not clearly identifiable, do pose a risk, as would any product where the concentration of active ingredient is not known. While cannabis users may be able to “auto-titrate” (regulate their level of intoxication by moderating consumption), this skill is less

developed in novice users. Some studies have found that, in practice, “users have limited ability to titrate their dose of THC” [210]. Luckily, high-THC cannabis products are often expensive and thus may be out of reach for many young people. However, as discussed above, survey data show that most people get their cannabis for free and that home-grown cannabis in particular is often distributed without cost to the user. Being part of a social network in which someone grows their own cannabis may be a more important determinant of access to high-potency cannabis than income.

In other drug markets, it is generally recognized that high variability in purity levels poses a risk for users. Many jurisdictions place age restrictions on access to more potent forms of alcohol. Spikes in heroin potency are accompanied by widespread overdoses. While it is more difficult to consume too much cannabis unwittingly than too much heroin, it is possible that even experienced users will be caught unaware by an unexpectedly powerful product. High-potency cannabis is effective within a “hit” (inhalation) or two and even given the rapid onset of action of cannabis, stronger herbal cannabis poses a greater risk of getting more intoxicated than desired.

Finally, all evidence indicates that, despite increases in potency in many markets, the size of cannabis cigarettes has not decreased in recent years. In fact, the data that do exist suggest that cannabis cigarettes have become bigger in many important markets. Larger cannabis cigarettes in the context of increasing potency without evidence of other changes in use patterns suggest an increase in THC consumption.

What evidence is there that the increase in high-potency market share is actually causing public health problems? If an increasing share of users is getting more than they bargained for from the cannabis they consume, this could be reflected in the number of people showing up at emergency rooms complaining of unexpected effects such as panic attacks, paranoia and delusions. Information on the number of people seeking emergency medical assistance with drug problems is available from the United States. It has also been argued that problematic symptoms of high-potency cannabis use could lead to more users seeking treatment and data on treatment admission are available from several developed countries. Both of these data sources are discussed below.

Has increased potency affected emergency room statistics?

One of the best data sets for evaluating the extent to which cannabis use contributes to acute medical problems comes from the United States. The Substance Abuse and Mental Health Services Administration of the Department of Health and Human Services is responsible for collecting a range of important indicators

about the state of substance abuse in the United States. These include the Drug Abuse Warning Network (DAWN), which records the number of cases in which medical staff from a representative sample of hospital emergency rooms determined that trauma of individuals presenting themselves for treatment was related to the use of legal or illegal drugs (referred to as "mentions"), and deaths that coroners determine to be drug-related ([83], p. 85). Of course, there are very few deaths attributable to cannabis use, but the number of cannabis-related emergency room episodes is substantial and has risen over the years.

According to the medical professionals participating in the DAWN system,* "marijuana" (which in this case includes "hashish") was a feature in 45,259 emergency room episodes in 1995. This represents 19 mentions per 100,000 members of the population, less than cocaine (58), heroin (30), or anti-depressants (23), but more than methamphetamine (7). The number of mentions grew to 119,472 in 2003, an increase of 164 per cent. Looking at these figures as rates, which would take into account the increase in population during this period, there were 47 mentions per 100,000 in 2002, an increase of 139 per cent over 1995. This increase is less than was seen for methylenedioxymethamphetamine (767 per cent), but more than for cocaine (33 per cent) or heroin (22 per cent).

These figures would support the argument that cannabis emergency room admissions have increased and have increased at a rate that is disproportionate to most other drugs of abuse. But other data from the Substance Abuse and Mental Health Services Administration indicate that overall levels of cannabis use also increased during this period. According to the United States National Survey on Drug Use and Health, the number of annual users of cannabis was 17,755,000 in 1995. This figure rose to 25,755,000 in 2002, an increase of 31 per cent.

Using these figures, we can calculate the number of drug users per emergency room cannabis mention. In 1995, there was one visit for every 392 people who used the drug that year. In 2002, there was one visit for every 216 users, an increase of 55 per cent. This suggests that the share of total cannabis users who find themselves in an emergency room has increased.

The total number of emergency room episodes captured by DAWN increased from 457,773 in 1995 to 681,957 in 2002, an increase of 33 per cent. During that same period, the number of users of any drug, according to the United States National Survey on Drug Use and Health, also increased, from 22,662,000 to 35,132,000, an increase of 34 per cent. Thus, the share of total annual drug users who visited an emergency room and mentioned a drug during admission did not change during these two years: about one visit for every 50 users. This suggests that the reach of the DAWN system remained fairly constant during this interval and

*See the website of the Substance Abuse and Mental Health Services Administration www.oas.samhsa.gov/dasis.htm#teds2.

that the increases are real increases, not just a product of better data collection: if the chances of any given drug user showing up in an emergency room with a drug-related problem remained constant during this period, the increase in the number of cannabis mentions is probably not a recording phenomenon.

However, when cannabis was mentioned, it was usually mentioned in combination with other drugs. In 72 per cent of the cases when cannabis was mentioned, other drugs were also mentioned. Thus, in only a minority of cases could it be clearly argued that cannabis was the only drug that might be involved in precipitating the visit to the emergency room. But the share of "cannabis only" mentions has increased since 1995, when 78 per cent of the episodes where cannabis was mentioned also featured other drugs, which supports the notion that the drug, on its own, is becoming more problematic.

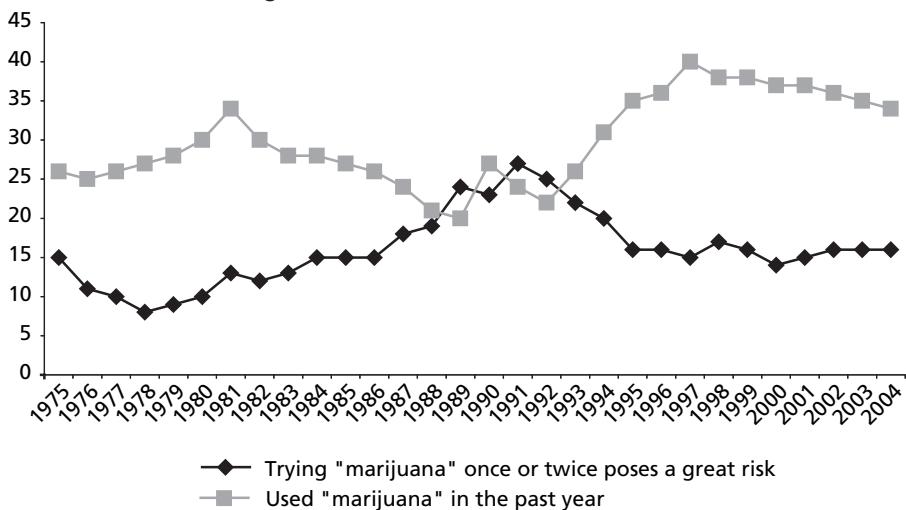
The DAWN data also explores the reasons for coming to the emergency room. Using the data sets available online (1994 and 1996), of those incidents where cannabis alone was mentioned, a large minority (48 per cent in 1994 and 43 per cent in 1997) said they had visited the emergency room because of an "unexpected reaction". The next most common response was "other" (21 per cent in 1994 and 20 per cent in 1997), followed by "accident/injury" (12 per cent in 1994 and 19 per cent in 1997). Few people mentioned "overdose" (less than 5 per cent), a need for detoxification (less than 5 per cent), or "withdrawal" (less than 1 per cent).

Thus, 40-50 per cent of the people who only mentioned cannabis said they were experiencing an unexpected reaction to the drug. This is high compared to other drugs, which would support the argument that cannabis, usually regarded as a fairly unproblematic drug, is surprising people to the point that they are seeking medical attention. The share of people so reporting, however, decreased between 1994 and 1996.

It is also clear from survey data that the perceived dangers of cannabis have varied over time. The fact that there are more emergency room mentions could be because more people who use the drug consider this fact to be relevant to their admission and are therefore reporting it in cases where they might not have done so before. But, at least among young people, perceptions of cannabis risk in the United States were highest in the late 1980s and early 1990s, when use was lowest. They declined through the 1990s and have been fairly low and stable since the turn of the century. Between 1994 and 1996, the belief that trying cannabis posed a great risk declined by about 4 per cent (see figure XXIV).

Thus, it would appear that emergency room mentions related to cannabis use are on the increase and that the most common reason for these visits is an unexpected reaction to the drug. This is consistent with the kind of effect that would be expected with the increasing circulation of high-potency cannabis.

**Figure XXIV. Perception that trying cannabis is dangerous, and annual use among United States pupils in the twelfth grade, 1975-2004
(Percentage)**



Source: Monitoring the future project [89].

Has increased potency affected treatment admissions?

In addition to acute episodes, high-potency cannabis could contribute to chronic problems in a variety of ways. It has been argued that increased potency represents increased addiction potential [214]. In addition, incidents of excessive intoxication due to a decline in the ability to auto-titrate could persuade users that their consumption is problematic.

Once again, the best data on treatment presentations comes from the largest cannabis market, the United States, in the form of the Treatment Episode Data Set, which tracks some 1.5 million admissions to drug treatment in facilities that report to state administrative data systems ([83], p. 305). Unfortunately, using these figures to determine the extent to which drug users are finding their consumption to be problematic is complicated by the fact that a large share of people entering treatment do not do so voluntarily. Some people enter treatment not because they find their drug use problematic, but because they were forced to do so by employers, the criminal justice system or their parents.

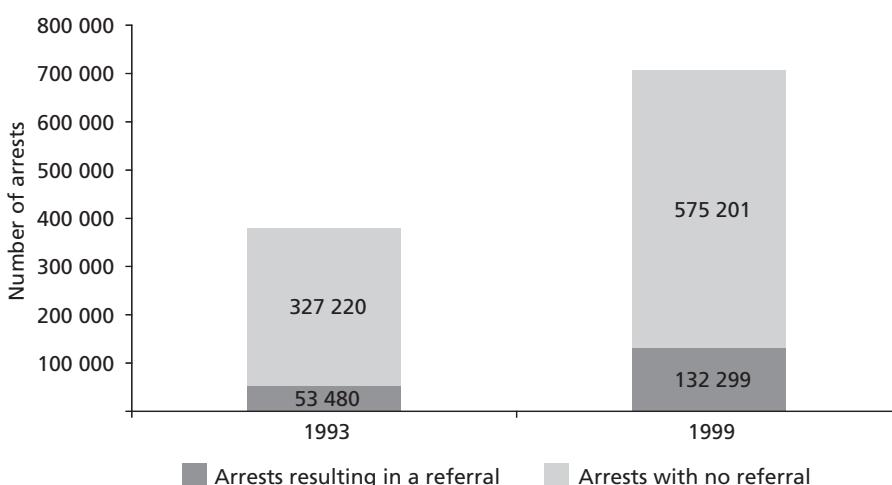
Workplace testing for drugs has increased considerably in the past few years, but only a small share of referrals for treatment to cannabis use come from employers, usually less than 2 per cent. The criminal justice system, on the other hand, represents a very significant source of referrals. Those apprehended in possession of cannabis (especially young people) are often given a choice in court: enter a

diversion programme for treatment or go to jail. These admissions may include experimental users caught with the drug on one or more occasions and an increase in their numbers could be more reflective of law enforcement priorities than changes in the dangers posed by the drug.

Within the Treatment Episode Data Set sample, national rates of admission to treatment for cannabis as a primary drug of abuse almost doubled between 1993 and 1999, from 55 admissions per 100,000 people to 103 [215]. According to the Data Set, 111,418 people were admitted to treatment in 1993 with cannabis as their primary substance of abuse, comprising 7 per cent of the overall treatment population. In 1999, this number was 232,105, comprising 13 per cent of the treatment population. In other words, the number of admissions related to treatment of cannabis use more than doubled in six years and, in addition, cannabis users nearly doubled their share of the treatment population.

This overwhelming increase would appear to provide very strong evidence that something dramatic had changed in the nature of the drug or the way that it was being used. But this increase took place at a time of renewed law enforcement focus on cannabis use: the number of cannabis arrests increased from 380,700 in 1993 to 707,500 in 1999, an increase of 85 per cent. During this same period of time, non-cannabis drug arrests increased by just 11 per cent [216]. Partly as a result of the increase, the share of cannabis users in treatment who were there following a criminal justice referral increased during this period (see figure XXV).

Figure XXV. Arrests related to cannabis in the United States resulting in a referral to treatment, 1993 and 1999

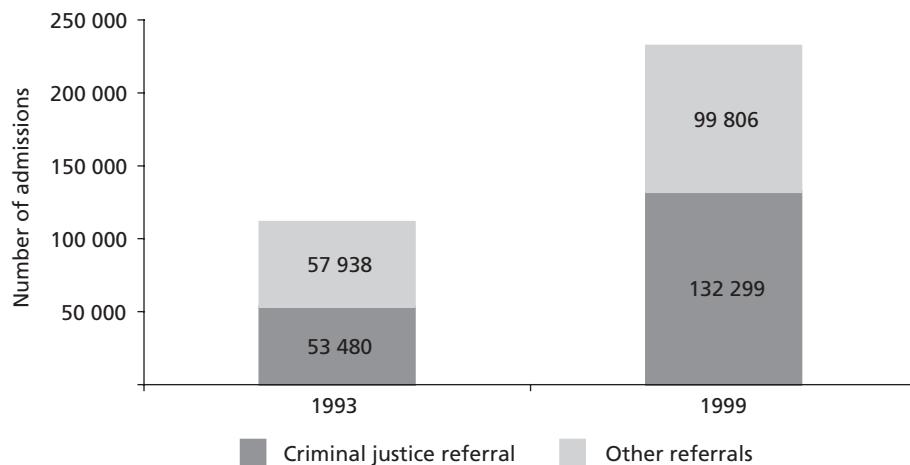


Source: United States, Treatment Episode Data Set and Uniform Crime Reports of the Federal Bureau of Investigation.

Evaluating the relationship between increased enforcement, increased diversion and increased treatment figures is not as straightforward as it might initially seem. Primary cannabis admissions increased in 41 states in the United States between 1992 and 2002, while decreasing in only 3. This is important because law enforcement in the United States is highly decentralized and generating such a widespread policy shift would be difficult, especially given the fact that several states have shown sustained interest in medical cannabis, in defiance of federal policy [217].

Within the Treatment Episode Data Set sample, almost half (48 per cent) of admissions for treatment for cannabis use were referred by the criminal justice system in 1993 (53,480 people); in 1999, the figure increased to 57 per cent (132,299 people) (see figure XXVI). In other words, criminal justice referrals to treatment in 1999 were responsible for 78,819 additional admissions, almost two thirds of the additional 120,687 cannabis admissions in 1999. In 2003, cannabis and stimulants (including ecstasy) were the only two drug categories in which the majority of referrals to treatment came from the criminal justice system. Non-criminal-justice referrals were more likely to report both daily cannabis use and the use of other drugs: in other words, they were more likely to reflect a serious drug problem [218].*

Figure XXVI. Share of cannabis admissions to treatment as a result of criminal justice referral, 1993 and 1999



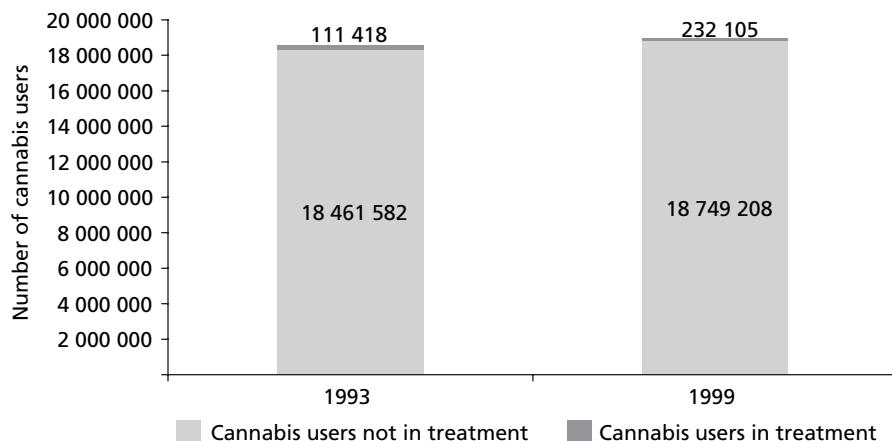
Source: United States of America, Treatment Episode Data Set.

*Of "marijuana" criminal justice referrals, 88 per cent were male, a larger share than those referred to treatment by other sources (66 per cent). Black people made up a larger share of criminal justice referrals (31 per cent) than of other source referrals (25 per cent). This also suggests that this increase is due to enforcement patterns, rather than changes in drug risk.

This still leaves an increase of 41,868 non-diversion cannabis admissions to account for between the two periods. Another factor to consider is the growth in the cannabis-using population during this time period. If the risk were to remain constant, a larger number of people being exposed to the drug could result in a larger number of admissions. According to United States National Survey on Drug Use and Health data, the total number of annual cannabis users in the United States was fairly stable between 1993 and 1999, rising slightly from 18,573,000 in 1993 to 18,981,313 in 1999, about a 2 per cent increase. In 1993, about one out of every 321 annual cannabis users entered treatment in one of the facilities monitored in the Treatment Episode Data Set without the criminal justice system being involved. In 1999, it was one out of every 191. Thus, there was a real increase in the likelihood that users would wind up in treatment, independent of the increase in criminal justice referrals. This suggests there were other factors at work than the increase in enforcement, the increase in diversion and the mild increase in general use.

As with emergency room mentions, a changing public perspective on the risks of using cannabis could account for a greater number of people entering treatment, especially among young people, who may be pressured into treatment by their parents and who represent a growing share of the treatment population. However, as argued above, young people were less likely to consider cannabis use risky in 1999 than in 1993. There are no measures of parental attitudes available, but the feelings of the general public, according to 1993 and 1999 data from the National Survey on Drug Use and Health, are the same. Although the question in this area changed between the two study periods, about 40 per cent of the general population thought that occasional cannabis use posed a great risk in both periods.

Figure XXVII. Share of cannabis users in treatment in the United States, 1993 and 1999



Source: United States, Treatment Episode Data Set and National Survey on Drug Use and Health.

A complicating factor, both in the United States and elsewhere, is the declining age of the treatment population. Younger people are more likely to use cannabis as their primary drug, so when the share of young people in treatment increases, cannabis admissions should also increase.

In summary, there are so many possible factors that may lead to an increase in admissions to treatment that it is impossible to say whether increases in potency might be the cause. It appears that changes in criminal justice policy were responsible for the bulk of the dramatic increase between 1993 and 1999, but they do not account for all of it. With regard to the treatment data, therefore, the case of the United States is inconclusive.

Another study sidesteps these difficulties and looks directly at nationally representative survey data on abuse and dependence. The survey finds that "overall rates of past-year abuse or dependency increased from 30.2 per cent in 1991-1992 to 35.6 per cent in 2001-2002". The study concludes that "A number of factors could have led to increases in addiction potential, operating independently or co-jointly. The first is increased marijuana potency . . . Increasing rates of marijuana use disorders among marijuana users in the absence of increased quantity and frequency of use strengthens the argument that the increasing rates may be attributable, in part, to increased potency of marijuana." [214]

Furthermore, the United States is not alone in seeing an increase in the number and share of cannabis admissions to treatment. A similar trend is seen in Europe, where most countries have been liberalizing their cannabis policies, rather than cracking down on users, in recent years. Treatment data within Europe are not uniform, so it is difficult to compare between countries. However, it would appear that cannabis has increased its share of the treatment population in all European countries for which records are available in recent years (see table 9). The increase is lowest in Greece and Italy, two countries that receive most of their herbal cannabis from Albania. Some of the countries where the market share of sinsemilla has increased, such as Germany and the Netherlands, have also seen dramatic increases in treatment share for cannabis. Exceptions include the United Kingdom (believed to be using more sinsemilla but with modest increases in treatment share) on the one hand and Sweden (still largely consuming cannabis resin but tripling admission share) on the other.

These figures refer to the share cannabis holds of the treatment population and thus documents that cannabis is becoming more problematic relative to other drugs. In most cases, this would also suggest an increase in absolute numbers of cannabis users seeking treatment. In 2004, 25 per cent of all new admissions to treatment in Europe listed cannabis as their primary drug of abuse.* This is a much higher share than in the past.

*EMCDDA, cited in Report of the International Narcotics Control Board for 2004 [211].

**Table 9. Share of primary cannabis users in the treatment populations of European countries
(Percentage)**

	1996	1997	1998	1999	2000	2001	2002	Increase
Denmark	..	11	..	..	..	..	27	145
Germany	18	..	..	..	30	66
Greece	6	..	..	..	7	17
Spain	..	4	..	..	..	..	11	175
France	..	11	..	14	..	..	..	27 ^a
Ireland	..	11	..	..	21	..	..	91
Italy	8	..	..	..	9	12
Luxembourg	..	4	..	..	..	..	11	175
Netherlands	11	..	..	..	17	55
Finland	..	18	..	..	..	..	23	28
Sweden	7	..	..	..	..	..	30	429
United Kingdom	..	8	..	..	..	..	10	25

Source: EMCDDA annual reports, 1999 [219] and 2002 [220].

Note: Two dots (..) indicate that data is unavailable or is not separately reported.

^aThe Observatoire français des drogues et des toxicomanies notes that if the variation in the number of organizations responding to the survey is taken into consideration, admissions for cannabis increased by 40 per cent between 1997 and 1999.

In some instances, the change in cannabis admissions in Europe has been quite dramatic recently. For example, one study of seven health board areas in Ireland (most of the country outside Dublin), a country where sinsemilla commands about half the small herbal cannabis market, the number of people seeking treatment who reported cannabis as a problem drug almost trebled between 1998 (626) and 2002 (1,831), with 70 per cent of these people reporting cannabis as their main problem drug. In addition to an increase in cannabis supply, an increase in access to services and an increase in the monitoring umbrella, the researchers involved credit “an increase in cannabis toxicity” for the growth in patient numbers ([221], p. 7).

In Australia, the “national censuses of Australian addiction treatment services indicate that the proportion of persons presenting for a primary cannabis-related problem . . . steadily increased from 4 per cent in 1990 to 7 per cent in 1995” ([210], p. 505). In 2002-2003, cannabis commanded 43 per cent of the non-alcohol treatment admissions (some 27,000 individuals), ahead of heroin and amphetamines ([222], p. 8). Criminal justice referrals made up at least 37 per cent of this treatment population, however ([222], p. 26). Independent of these data, it has been argued that an increasing number of people are seeking treatment for cannabis problems in centres used to treating alcohol and opiate dependence [223]. The reasons for this increase remain unclear.

Even in South Africa, a country with a plentiful supply of cannabis from outdoor growth, there are indications that indoor cannabis has grown in popularity in recent years. Cannabis has also grown in its share of admissions to treatment in the major urban centres, including Cape Town (4 per cent in 1996 to 11 per cent in

2004), Durban (10 per cent in 1996 to 25 per cent in 2004) and Gauteng, which includes Johannesburg and Pretoria (11 per cent in 1998 to 19 per cent in 2004), as well as the rural province of Mpumalanga (14 per cent in 1999 to 24 per cent at the end of 2004).* This is remarkable in that a number of other street drugs were growing in popularity during this time, so that cannabis largely filled the spots vacated by a decline in alcohol admissions. Since it is unlikely that the severity of alcoholism in the country declined during this period, this means that cannabis admissions essentially displaced alcohol admissions. Whether this is possibly due to increased potency is unknown: South African cannabis is rarely tested for THC levels and other factors, such as the declining age of the treatment population, may be responsible.

Health effects

The widespread use of cannabis is clearly related to the public perception that smoking herbal cannabis is virtually harmless.** Ironically, this is, in part, a reaction to early demonization of the drug, which undermined the credibility of subsequent health warnings. In addition, a sizeable share of the population in the world has experimented with cannabis and not experienced dramatic negative repercussions. It is widely understood that, unlike other drugs, one cannot die of a cannabis overdose and few people develop cannabis habits that force them into street crime or prostitution. Cannabis is not associated with violent behaviour in many countries and its role in accidents is vague in the public mind. The stereotypical "stoner" character has become celebrated in the popular media as harmless and somewhat endearing. Claims of purported medical benefits of cannabis have created the impression that cannabis is not only virtually harmless but that it can actually be beneficial to health.

Despite the good press, cannabis remains a powerful drug. As will be discussed, cannabis use affects virtually every organ system of the body, from the central nervous system to the cardiovascular, endocrine, respiratory and immune systems [225]. The psychological effects of the drug are frequently underestimated. Its impact on the psyche and behaviour of users can be considerable. Few casual users of cannabis know that cannabis dependence is a major issue in countries where use levels are high. A significant share of people who use cannabis regularly find it hard to stop and say it has other negative effects on their quality of life.

There have been many recent reviews of the literature on the health impacts of cannabis. The present article uses the one published by WHO in 1997 [226] as a point of departure, focusing on the major new findings since that review was

*The differing time frames are due to availability of data ([224], p. 7).

**The National Surveys on Drug Use and Health in the United States have shown that trends in cannabis use levels are strongly linked to public perceptions about the harmfulness of the drug.

conducted. The health effects of cannabis were also examined in an edition of the *Bulletin on Narcotics* in 1998 [227].

Effects on the brain and behaviour

People smoke cannabis because it significantly changes their state of mind. The acute effects of cannabis use are an altered state of consciousness characterized by euphoria and relaxation, perceptual alterations, time distortion and the intensification of ordinary sensory experiences. When used in a social setting it can produce infectious laughter and talkativeness [228]. It is not surprising that the overwhelming reason for taking cannabis given by recreational users is simply "pleasure" [229, 230].

But altered consciousness comes at a cost. Short-term memory and attention, motor skills, reaction time and skilled activities are impaired while a person is intoxicated [228]. This has a potential impact on driving skills and involvement in accidents. Moreover, cannabis has the ability to produce dysphoric reactions, including severe anxiety and panic, and paranoia. These reactions are dose-related and more common in naïve users, anxious subjects and psychologically vulnerable individuals [231, 232].

In addition to its acute effects, cannabis use can produce long-term psychological problems. There is growing evidence that it can trigger latent psychosis and promote personality decompensation in diagnosed schizophrenics. Finally, some regular cannabis users find it difficult to stop using the drug, even when it is having adverse consequences for their lives.

Is cannabis use associated with vehicular accidents?

The debate around cannabis and driving has been protracted. Many early reports suggested that cannabis was not associated with vehicular accidents, noting that cannabis smokers seemed more aware of their inebriation than drivers under the influence of alcohol and were able to compensate by driving more carefully [233]. WHO, in contrast, states that there is sufficient consistency in the experimental evidence and studies among accident victims to conclude that there is an increased risk of accidents in people who drive when intoxicated with cannabis ([226], p. 15). Subsequent research has pointed in both directions.

Research in this area has been complicated by the way cannabis is metabolized. THC is fat-soluble and quickly passes out of the blood into the brain and other organs, where it and its metabolites can remain for extended periods of time before slowly being excreted. Thus, the detection of cannabis metabolites in urine only serves to prove that the subject has used cannabis at some time in the recent past, not that intoxication was indicated at the time of the testing. And, unlike

alcohol, even blood tests are not always reliable measures of the level of intoxication, particularly if they measure metabolites instead of THC. Perhaps partly as a result, the more recent studies in this area reach conflicting conclusions.

For example, a prospective observational case-control study from the Netherlands of accidents requiring hospitalization showed no increased risk for road trauma for drivers exposed to cannabis, although high relative risks were found for drivers using a combination of drugs and for those using a combination of drugs and alcohol [234]. In a review by Bates and Blakely (1999), the authors conclude that, in contrast to alcohol, there is no significant evidence of a causal role for cannabis alone in traffic accidents [235]. A longitudinal study of a birth cohort of 907 young New Zealanders (age 18–21 years) did detect a statistically significant relationship between reported annual cannabis use and annual accident rates, but these increased risks may simply reflect the characteristics of the young people who used cannabis (i.e., higher rates of drinking and driving; risky or illegal driving behaviours; driver attitudes; and gender differences) [236].

On the other hand, surveys that established recent use of cannabis by directly measuring THC in the blood showed that drivers with THC positives, particularly at higher doses, were about three to seven times more likely to be responsible for accidents in which they were involved as compared to drivers that had not used drugs or alcohol [237]. In addition, laboratory studies of driving by subjects given known quantities of THC have repeatedly found a connection between cannabis intoxication and bad driving, as THC impairs cognition, psychomotor function and actual driving performance in a dose-related manner. The degree of performance impairment observed in experimental studies after doses of up to 300 micrograms per kilogram THC were equivalent to the impairing effect of an alcohol dose producing a blood alcohol concentration of 0.05 gram per decilitre, the legal limit for driving under the influence in most European countries. Highly automated behaviours, such as road tracking control, were more affected by THC as compared with more complex driving tasks requiring conscious control [237]. Other research has reached similar conclusions, including:

- A recent study of over 10,000 accidents in France ("Stupéfiants et accidents mortels de la circulation routière") found that cannabis smokers were almost twice as likely to be responsible for an accident, although this was still less than those even moderately intoxicated by alcohol [238].
- O'Kane and others (2002) in a review of laboratory studies, real driving studies and recent epidemiological studies concluded that cannabis had a significant impairing effect on driving when used alone and that this effect was exaggerated when combined with alcohol [239].
- In a placebo-controlled double-blind study, the performance of 60 healthy drug-free volunteers on a battery of psychomotor and cognitive tests was assessed in baseline condition and then after smoking a regular cigarette

or one containing THC. The authors found that perceptual motor speed and accuracy were significantly impaired immediately after cannabis consumption, but not on re-testing 24 hours later [240].

- Several studies have found high rates of positive urine tests for cannabis metabolites among trauma patients suffering from non-motor accidents as well.*

Progress in this debate might be assisted by standardizing methodologies and finding more accurate ways of documenting current cannabis intoxication. One way of sidestepping the scientific problems is to ask the users themselves if they feel that the perceptual distortions associated with cannabis consumption affect their driving. For example, one survey of regular cannabis users in Australia reported a quarter (25 per cent) of respondents felt that their driving performance was impaired, their reflexes and reaction times slowed and their concentration affected when attempting to drive under the influence of cannabis ([23], p. 34). The fact that over half of those polled in the national surveys on drug use in New Zealand say they never drive when under the influence of cannabis also demonstrates that cannabis users themselves feel that cannabis impairs their driving performance ([60], p. 34).

Does cannabis use have an impact on cognition?

The short-term impact of cannabis on cognitive and psychomotor performance has been recognized for many years. The effects are similar to those of alcohol and benzodiazepines and include the slowing of reaction time, motor incoordination, impairment in short-term memory, difficulty in concentration and slower problem-solving. The effects are dose-related but can be demonstrated after relatively small doses (5-10 milligrams of THC), even in experienced users [231].

The long-term impacts are the subject of ongoing research and debate. WHO, in contrast to earlier heavy-user studies, concluded that long-term use resulted in “subtle and selective impairments of cognitive functioning” ([226], p. 16). Since then, there have been a number of studies that have detected a range of effects, and some that have found none.

In the past, research in this area has struggled to distinguish between effects that might be attributable to current intoxication, withdrawal effects and true brain

*Studies of other forms of accidents suffer from the same weaknesses as the vehicular studies, but next to alcohol, cannabis is the substance most associated with injury in adult trauma patients. While baseline figures for the general population were not available, of 105 adult trauma patients admitted to one South African trauma unit, 43.7 per cent tested positive for cannabis in the urine [241]. Of 111 patients with trauma injuries who presented to the Accident and Emergency Unit, University Hospital of the West Indies, 50 per cent of road accident victims and 55 per cent of interpersonal violence victims tested positive for cannabis, compared with 43 per cent and 27 per cent for alcohol, respectively [242]. Studies of non-clinical samples have shown that cannabis use is related to intentional injuries and injuries in general. A higher risk for all types of injuries was indicated among cannabis users [243].

damage. This work has generally involved administering computerized cognitive batteries and pencil-and-paper tests to long-term users and comparing them to groups of controls. Solowij and others [244] performed a multi-site retrospective cross-sectional neuropsychological study in the United States between 1997 and 2000 among 102 near-daily cannabis users who had come seeking treatment for cannabis dependence (51 long-term users: mean, 23.9 years of use; 51 shorter-term users: mean, 10.2 years of use), compared with 33 non-user controls. A battery of tests of attention, memory and executive functioning were carried out. The longer-term cannabis group performed significantly worse on the test battery than the shorter-term users and the controls. Performance measures often correlated significantly, with performance being worse with increasing years of use.

The possibility of dose-related neurocognitive effects of cannabis use has been investigated by Bolla and others. It had been shown that as the number of cannabis cigarettes smoked per week increased, performance decreased on tests measuring memory, executive functioning, psychomotor speed and manual dexterity. The heavy-users group performed significantly below the light-users group. In this study, however, it was found that the duration of use had little effect on neurocognitive performance [245].

Two recent neurophysiological studies of selective attention and information processing confirmed previous findings. Visual information processing (as measured by the binocular depth inversion illusion) [246] and auditory information processing (as measured by auditory evoked potential latency) [247] were both found to be impaired in chronic cannabis users compared to non-users. However, these findings are probably reflections of acute cannabis intoxication and do not necessarily indicate long-term or permanent alterations.

The inspection time task was used to investigate the effects of acute and sub-acute cannabis use on information processing in a study in 22 heavy users, compared to 22 non-cannabis-using controls. Findings indicated that users displayed significantly slowed information-processing speeds (longer inspection times) compared to controls, when not presently under the influence. Remarkably, this deficit appears to be normalized while users are under the influence. These results may be explained as a withdrawal effect, but may also be due to tolerance development as a result of long-term cannabis use. If regular cannabis users require the drug to perform normally, these results may assist in providing an explanation for the development of dependence with chronic cannabis users [248].

On the other hand, an epidemiological study of 1,318 individuals performed by Lyketsos and others showed no significant cognitive differences between heavy users, light users and non-users of cannabis. The authors conclude that over long time periods, in persons under age 65 years, cognitive decline occurs in all age groups. This decline is closely associated with ageing and educational level but does not appear to be associated with cannabis use [249].

Does cannabis use lead to psychiatric problems?

The excesses of the “reefer madness” propaganda of the early anti-drug campaigns in the United States are responsible in no small part for the lack of credibility given to official pronouncements on the risks of cannabis and drugs more generally. The experiences of the millions of people that have tried cannabis attest to the fact that madness does not inevitably follow from cannabis use but, despite this, there is growing evidence that use of the drug may have an important impact on mental health. In the past eight years, several major reviews of the psychiatric problems associated with cannabis use have been conducted, including those by Hall and Degenhardt [250], Johns [251] and Iversen [252].

With regard to the acute effects of the drug, it is clear that cannabis can cause some dysphoric effects when used in high doses, including panic and delusions. One survey found that anxiety and panic attacks were the most commonly experienced negative side effects of the drug, experienced by 22 per cent of the users polled, and that 15 per cent experienced psychotic effects [253]. Whether this amounts to “cannabis psychosis” is debated and WHO found that the existence of such a disorder would require further research evidence. More recently, Hall and Degenhardt concluded from their review of the literature that true “cannabis psychosis”, if it exists, must be very rare [250]. This position found confirmation in a recent review by Schaub and others (2004): very high doses of cannabis can induce a brief psychosis, but this condition is extremely rare [254]. In contrast, Johns mentions in his review that an appreciable proportion of cannabis users report short-lived adverse effects, including psychotic states, following heavy consumption [251].

With regard to long-term effects, several impacts have been hypothesized. One of the early attempts to describe the negative impact of cannabis on the mental state of users is the so-called “amotivational syndrome”, a personality deterioration with loss of energy and drive to work [255]. Again, WHO was unable to confirm the existence of such a syndrome based on the research in 1997. The state of evidence on amotivational syndrome largely comprises uncontrolled studies of long-term cannabis users in various cultures [256]. Evidence to the contrary is seen in cultures where cannabis is traditionally consumed to increase work output, such as South Africa and Jamaica. Due to the lack of a strong evidence base, the validity of this diagnosis remains uncertain [256].

More worrying is the conflicting evidence around the claim that cannabis can either cause psychosis in vulnerable individuals or precipitate latent psychosis. WHO argues that there is clear evidence of an association between cannabis use and schizophrenia. One recent review of the literature determined that cannabis exposure is associated with an increased risk of psychosis, possibly by interacting with a pre-existing vulnerability for these disorders. A dose-response relationship was found between cannabis exposure and risk of psychosis and the association

was independent from potential confounding factors such as exposure to other drugs and pre-existence of psychotic symptoms [257].

This effect appears to be particularly strong when the user has developed cannabis dependence (according to the fourth edition of the Diagnostic and Statistical Manual of the American Psychiatric Association; see the discussion of “dependence” below). Increased rates of psychotic symptoms were found to be associated with the development of cannabis dependence in young people (ages 18 and 21 years) in a longitudinal study of a birth cohort of 1,265 individuals in New Zealand, even when pre-existing symptoms and other background factors were taken into account [258].

Since some schizophrenics “self-medicate” with cannabis, it can be difficult to determine the lines of causation. The causal relationship between schizophrenia and cannabis use was studied in a representative first-episode sample of 232 patients with schizophrenia in Germany. While cannabis use almost always preceded the first positive symptoms of schizophrenia, the comparison of the onset of cannabis abuse and of the first (prodromal) symptoms of schizophrenia differentiated three equally sized groups of patients: group one had been using cannabis for several years before the first signs of schizophrenia emerged, group two experienced their first signs of schizophrenia within the same month of starting cannabis use, and group three had started to use cannabis after the onset of symptoms of schizophrenia [259].

An association between use of cannabis in adolescence and subsequent risk of schizophrenia was also reported in a follow-up study of Swedish conscripts. The authors later extended the follow-up period and identified additional cases. Between the two studies, 50,087 subjects participated. Cannabis was associated with an increased risk of developing schizophrenia, consistent with a causal relation. This association was dose dependent both for subjects who had ever used cannabis and for subjects who had used only cannabis and no other drugs. Among subjects in the cannabis-only group who had used cannabis more than 50 times, the odds ratio (a measure of relative risk) was 6:7. Similar results were obtained when analysis was restricted to subjects developing schizophrenia more than five years after conscription, in order to exclude cases that might have already been in the early stages of schizophrenia at the time of their conscription [260].*

Studies have also indicated that early use of cannabis is associated with the later development of psychosis. The Dunedin longitudinal study of adolescent cannabis use found that using cannabis in adolescence increased the likelihood of experiencing symptoms of schizophrenia in adulthood among psychologically vulnerable individuals. Moreover, the authors added that early cannabis use (by age 15) conferred greater risk for schizophrenia outcomes than later cannabis use (by age 18). This risk was specific to cannabis use, as opposed to use of other drugs [262].

*A further analysis of this cohort was performed by Zammit and others [261].

The adverse effect of cannabis use on the clinical course of schizophrenia has been confirmed in a three-year follow-up study of psychotic and non-psychotic subjects in the Netherlands. Cannabis use increased the risk of both the incidence of psychosis in psychosis-free persons and a poor prognosis for those with an established vulnerability to psychotic disorder. The severity of symptoms was correlated with the length of the preceding cannabis use [263]. These results confirm the previous findings of a study comparing two matched groups of 39 schizophrenic patients each with or without a history of cannabis use. Patients with previous cannabis abuse had a more severe course of symptoms during the follow-up period [264].

Aside from full-blown psychosis, cannabis is associated with other forms of mental illness. Troisi and others found that the prevalence of co-morbid psychiatric disorders and the severity of depressive and anxiety symptoms increased progressively with the degree of involvement with cannabis [265].

Arendt and Munk-Jorgensen compared 1,439 heavy cannabis users with 9,122 abusers of other substances. The authors found that even though cannabis users were generally young, 27.5 per cent had, at some point, been inpatients at psychiatric hospitals with disorders unrelated to psychoactive substance abuse. As to psychiatric co-morbidity, cannabis users had significantly raised levels of depression and personality disorders while the prevalence of schizophrenia was also marginally raised [266].

A link between cannabis and major depression was found in an epidemiological study of 6,792 young adults in the United States. The risk of major depression was moderately associated with the number of occasions of cannabis use and with more advanced stages of cannabis use [267]. These data were later confirmed in a review of cohort studies and well-designed cross-sectional studies in the general population. A modest but significant association was found between early-onset, regular cannabis use and later depression. On the other hand, some evidence was also found of an increased risk of later cannabis use among people with depression. This would support the hypothesis that people dealing with mental illness may turn to cannabis or other drugs in an attempt at self-medication. Little evidence was found of an association between depression and infrequent cannabis use [268].

In addition, previously, in a nationally representative sample of 1,941 men from the 1944-1954 birth cohort in the United States, a small increased risk of developing depression in adulthood after early cannabis use was observed. Adult frequency of cannabis use, however, was not significantly associated with increased depression in adulthood. Finally, cannabis users who used the drug to cope with problems were more depressed than those who did not use it to cope with problems [269].

Depression and anxiety were observed in a seven-year cohort study of 1,601 secondary school students in the Australian state of Victoria, aged 14-15 years

at the start of the study. By the age of 20 years, some 60 per cent of participants had used cannabis and 7 per cent were daily users. Weekly or more frequent cannabis use in teenagers predicted a doubling of the risk for later depression and anxiety. The authors found a significant interaction between sex and daily cannabis use. Female students with a history of daily cannabis use had over a fivefold increase in risk of later depression. In contrast, depression and anxiety in teenagers predicted neither later weekly nor daily cannabis use. This allowed authors to conclude that frequent cannabis use in teenage girls predicts later depression and anxiety, rather than that these mental symptoms predict later cannabis use [270].

Furthermore, research based on the Christchurch cohort study (a 21-year longitudinal study of a birth cohort of 1,265 New Zealand children) concluded that a significant link existed between the frequency of cannabis use and negative psychosocial outcomes, including property and violent crime, depression, suicidal behaviours and other illicit drug use. Especially for the measures of crime, suicidal behaviours and other illicit drug use, there was evidence of age-related variation in the strength of association with cannabis use, with younger (14-15 years old) users being more affected by regular cannabis use than older (20-21 years old) regular users. The association between cannabis use and depression did not vary with age [271].

In contrast, work in the Dunedin longitudinal study came to the conclusion that early cannabis use (by age 15 years) did not predict later depression [262]. The different outcomes in the last two studies may be due to differences in methodology, quantitative measures of symptoms and cannabis use, diagnostic labels and definitions of cannabis users [272].

However, cannabis use and other psychosocial problems may have common roots. Preliminary evidence of an association between childhood maltreatment and cannabis dependence among an especially vulnerable population was shown in a recent study. In a study of 18 African American, socially disadvantaged, first-episode schizophrenia-spectrum patients, those with cannabis dependence (8 patients) were found to have experienced greater levels of childhood abuse and neglect than similar patients without cannabis dependence, suggesting an association between childhood maltreatment and cannabis dependence among this vulnerable population [273].

A significant association between cannabis use and poor mental health was found in adolescents and young adults during the Dunedin long-term prospective study. Cannabis use and poor mental health were linked to low socio-economic status, a history of behavioural problems in childhood and low parental attachment in adolescence. Mental disorder at age 15 led to a small but significantly elevated risk of cannabis use at age 18; by contrast, cannabis use at age 18 elevated the risk of mental disorder at age 21. The authors conclude that the primary causal direction leads from mental disorder to cannabis use among adolescents and the reverse

in early adulthood. In contrast, alcohol use and cigarette smoking had independent associations with later mental health disorders [274].

Current heavy cannabis use appears to have a negative impact on intelligence. In one study, intelligence quotient (IQ) scores were examined before, during and after cessation of regular cannabis use to determine any impact of the drug on this measure of cognitive function. It was found that current cannabis use was significantly correlated in a dose-related fashion with a decline in IQ over the ages studied. Current cannabis use had a negative effect on global IQ score only in subjects who smoked five or more cannabis cigarettes per week (heavy users). A negative effect was not observed among subjects who had previously been heavy users but were no longer using the substance. Smoking at least five cannabis cigarettes weekly should not be interpreted as a definitive threshold, as subjects were at low risk for other factors that could have a negative synergistic effect on IQ score. The authors conclude that cannabis does not have a long-term negative impact on global intelligence; however they identified the need for further investigation of the cognitive consequences of both current and previous cannabis use, especially a residual cannabis effect in more specific cognitive domains such as memory and attention [275].

Cannabis use in early adolescence appears to have the ability to interfere with the normal development process. For example, one study pointed out that long-term cannabis users with an early age of onset of drug consumption (age 14 to 16 years) showed a specific deficit in visual scanning. A group of cannabis users (17 participants) compared with a control group (20 participants) showed less effective search behaviour, including longer response times and more fixations at about the same error level [276].

Furthermore, an early age of onset, rather than other potential predictors of test performance such as present age, degree of acute intoxication or cumulative toxicity, was found to be the only factor predicting enduring effects on specific attentional functions in adulthood. Visual scanning undergoes a major maturation process around the age of 12-15 years and it is known to react specifically and sensitively to cannabinoids. A comparison of a group of young adults who were regular users of cannabis (and only cannabis) with a group of non-users on a battery of tests of selective attention, one of which was a test of visual scanning attention, showed that the performance of cannabis users was selectively worse on the visual scanning attention test, and the only feature that correlated with this impairment was the age at which participants had begun to use cannabis. Apparently, vulnerable periods during brain development exist that are subject to persistent alterations by interfering exogenous cannabinoids [277].

Is cannabis use associated with aggression and violence?

The argument is made by many that cannabis is a “soporific” and therefore the historical associations the drug has with violence are unfounded. For example,

Booth discounts the claim that the Nizari Ismaili, the medieval militant Islamic sect who gave rise to the term “assassin”, fought under the influence of cannabis resin, because “‘hashish’ does not produce any mental state that would incite either violence or brutal murder” ([278], p. 85). Similarly, he rejects the claim that Zulu warriors smoked cannabis to steel their courage prior to military confrontations. In both cases, he writes off contemporaneous accounts as biased by intercultural misunderstanding.

This position seems to underestimate the importance of “set and setting” in understanding the impact of any drug. Research has illustrated that the effects of a drug are not simply a product of its chemistry, but rather the interaction of this chemistry with the user’s situation, mindset and immediate environment when taking the drug. So, while in the Western paradigm, cannabis is seen as a drug inducing levity and sloth, this may not be the only interpretation that could be given to its physiological effects.

Depending on the dose, cannabis is generally classed as a “hallucinogen”, not a sedative or depressant. According to Grotenhermen, “In many species the behavioural actions of low doses of delta-9 THC are characterized by a unique mixture of depressant and stimulant effects in the central nervous system.” He notes clinical observation of both euphoria and dysphoria; of anxiety and reduction of anxiety. Heart rate is raised, body temperature drops and thought processes are disturbed, for better or worse ([279], p. 56). Some users refer to cannabis as a “mood enhancer”.

There may also be a chemical basis for the differing views on the subjective effects of cannabis on aggression. In South Africa to this day, African people see cannabis as a stimulant, which eases labour, fuels creativity and can fuel violence [56]. Rottanburg and others note that South African cannabis smokers seem to be particularly prone to psychosis with hypomanic features.* The cannabis native to this area is considered a pure sativa, with very little CBD ([13], pp. 21-24), which is believed to affect perceptions of the stimulant effects of the drug,** and which may possess anti-psychotic properties ([280], p. 6). It may be that more attention needs to be paid to the variability of the cannabis plant before generalizing about its subjective effects.

There is little in the Western scientific literature to support the contention that cannabis is strongly associated with violence, however. One study tracked domestic

*Rottanburg and others, cited in Mechoulam and Hanuš ([280], p. 6).

**Absence of CBD has been noted in samples from Brazil, Costa Rica, Cyprus, Nigeria and other parts of Southern Africa. India and Mexico have produced both low and high CBD samples (see Baker, Gough and Taylor [15]). Other low CBD varieties are found in Ghana, Jamaica, Kenya, Myanmar and Thailand (see Clarke [47]). In Jamaica, cannabis is used as a stimulant to allow manual labourers to work harder (Dreher, cited in Grinspoon [95]). According to Grinspoon, “Many psychiatrists in India, Egypt, Morocco and Nigeria have declared emphatically that the drug can produce insanity.” It is possible that at least the Indian and Nigerian reports may be rooted in the low CBD plants available in these areas.

violence incidents among a group of 149 violent men entering a drug abuse treatment programme during a 15-month period. No significant association of cannabis and violence was found. In contrast, the use of alcohol and cocaine were associated with significant increases in the daily likelihood of male-to-female physical aggression [281]. A negative association of cannabis and interpersonal violence was also found in a study of 204 incarcerated adolescents [282]. One review concluded that cannabis was likely to reduce violence during intoxication, but noted that mounting evidence associated withdrawal with aggression [283]. For example, an association between aggression and cannabis withdrawal was seen in one study of daily, long-term users [284].

There is some research that does find a link between cannabis and violent crime. For example, one study looked at the association between 10 types of drug and criminal offences in a high-risk sample. Greater frequency of cannabis use was “unexpectedly” associated with weapons offences and this association was not found for any other drug besides alcohol. Cannabis use was also associated with attempted homicide and reckless endangerment offences [285]. Another study found that one third of murderers who had ever used cannabis had consumed it in the 24 hours preceding the murder, three quarters of whom reported experiencing effects of the drug during the crime, and 7 per cent of the entire sample felt that their cannabis use had been a factor in their crimes [286]. While these studies fall far from demonstrating that cannabis and violence are deeply linked, they do contradict the view that cannabis intoxication makes violence unthinkable.

Is cannabis a “gateway” to other drugs?

One of the perennial debates surrounding the impact of cannabis relates to the so-called “gateway” hypothesis: cannabis opens the door to the subsequent use of other drugs. Much of the early work in this area suffered from the *post hoc ergo propter hoc* logical fallacy. The fact that many users of other drugs report first using cannabis does not demonstrate a causal link between the two behaviours and even a cursory look at the survey data illustrates the fact that most people who try cannabis do not go on to use other drugs.

Early discussions of the gateway hypothesis were undermined by a lack of a clear argument on the mechanism of causation. Does cannabis cause some sort of change in the brain that compels users to pursue other substances, or is the hypothetical causation the result of social factors? One of the most compelling of these possible links is the claim that cannabis introduces users to the experience of procuring illegal drugs, that cannabis vendors may sell multiple substances, and that these vendors have a profit incentive to move users on to the consumption of other drugs. This argument is also used by those who champion decriminalization of cannabis sales, as decriminalizing cannabis would “take it out of the hands of criminals”. Both of these perspectives are substantially challenged by survey

evidence that most cannabis circulates among friends* with only a minority of purchases being made from professional polydrug dealers.

More sophisticated recent studies indicate there may be more to the gateway hypothesis than its early incarnations suggested, however. One remarkable study of twins was conducted in Australia. A national volunteer sample of 311 young adult, identical and fraternal same-sex twin pairs were assembled. In each case, one twin had used cannabis before the age of 17 years, while the other had not. Individuals who used cannabis by age 17 years were 2.1 to 5.2 times more likely than their co-twin to have experienced other drug use, alcohol dependence and drug abuse or dependence. Controlling for known risk factors (early onset alcohol or tobacco use, parental conflict or separation, childhood sexual abuse, conduct disorder, major depression and social anxiety) had only negligible effects on these results. The authors concluded that associations between early cannabis use and later drug use and abuse or dependence cannot solely be explained by common predisposing genetic or shared environmental factors. They argue, as suggested above, that association may arise from the effects of the peer and social context within which cannabis is used and obtained. In particular, early access to and use of cannabis may reduce perceived barriers against the use of other illegal drugs and provide access to those drugs [287].

Cannabis dependence

Traditionally, cannabis was regarded as a non-addictive drug because of the lack of observed physiological withdrawal symptoms. Further, animals failed to self-administer the drug, a behaviour usually associated with drugs of addiction [288].** However, the terminology around addiction changed with the publication in 1994 of the fourth edition of the American Psychiatric Association Diagnostic and Statistical Manual. Rather than "addiction", the Manual refers to "substance dependence", a condition that requires no physical withdrawal symptoms. The emphasis is now on the inability to end use despite the desire to do so and the problems that use causes in the lives of the dependent person [290]. At the same time, new research indicates that heavy cannabis users do experience a clinically significant withdrawal syndrome, although its effects appear to be relatively mild. Animal studies have indicated chronic administration of cannabinoids leads to adaptive changes in the brain, some of which are similar to those seen with other drugs of dependence ([291], p. 32). Animals will "work" to be given the opportunity to self-administer the drug [292].

According to data from the United States National Survey on Drug Use and Health, 27 per cent of lifetime cannabis users have only used the drug once or twice

*See the opening discussion of section II above.

**Later research, however, found tolerance, withdrawal and dependence in animals (see Farrell [289]).

and 54 per cent have used it 10 times or less. The majority of people who try cannabis do not become dependent, or even regular users. But survey data from Ireland show that a significant minority (28 per cent in 2002/2003) of lifetime users have, at some point in their smoking career, consumed the drug regularly (20 days or more a month). Of those who had been regular users in the past, some 12 per cent said they had tried to stop and failed and 30 per cent said they had never tried to stop [24]. WHO cites research indicating that about half of those who use cannabis daily will develop dependence, which is roughly consistent with these findings. WHO also points out that the low number of users presenting for treatment relative to the size of the user population suggests that there is a high rate of remission even in the absence of treatment.*

As Budney and Moore concluded in their review of the past 10-15 years of clinical and research experience, there is strong evidence demonstrating that cannabis can and does produce dependence. Clinical and epidemiological studies indicate that cannabis dependence is a relatively common phenomenon associated with significant psychosocial impairment [293].

For example, a prospective longitudinal study of a representative sample of 2,446 German cannabis users aged 14-24 years found the probability of developing cannabis dependence was 8 per cent [294]. A similar figure (7 per cent) was found in the Victorian Adolescent Health Cohort Study, in Australia. Cannabis dependent subjects were more likely than alcohol dependent subjects to report compulsive and out-of-control use [295]. In a study of the Dunedin Multidisciplinary Health and Development Study birth cohort, 10 per cent of the cannabis users developed cannabis dependence. Cannabis dependence, as distinct from occasional use, was associated with high rates of harder drug use, selling of drugs and drug conviction [296]. Similarly, 10 per cent of the New Zealand birth cohort study showed clear symptoms of cannabis dependence by the age of 21 years, especially males who were prone to other forms of risk-taking behaviours [297].

One comparative review of drug dependence risk found an estimated 9 per cent of lifetime users will develop cannabis dependence at some point. This risk, however, is less than with many other drugs, including legal drugs. It is estimated that 15 per cent of alcohol users, 23 per cent of opiate users and 32 per cent of tobacco users will develop dependence on the drug [298].

Of the 9 per cent of those who try cannabis and go on to develop dependence, it is estimated that 80 per cent of these people will not seek treatment [223]. Despite this, just under one million people participate in rehabilitation programmes every year for help with their cannabis problems in the United States alone. Globally, more people receive treatment for cannabis than for any other drug group besides

*Anthony and Helzer cited in Cannabis: a Health Perspective and a Research Agenda ([226], p. 18).

heroin. As discussed in section I, the exact numbers may be misleading, because in places like the United States, convicted users may be given a choice between time in prison and treatment. But even in countries where this policy does not exist, large shares of the total treatment population say their primary drug is cannabis according to responses to the UNODC annual reports questionnaires and its Database for Estimates and Long-term Trend Analysis. In a number of African countries, cannabis exceeds even alcohol in demand for treatment.*

Other reviews have suggested lower levels of dependence among lifetime users. A study of over 10,000 Australian adults found 1.5 per cent (according to criteria in the American Psychiatric Association *Diagnostic and Statistical Manual*) or 1.7 per cent (according to criteria in the tenth revision of the WHO *International Statistical Classification of Diseases and Related Health Problems*) of lifetime users developed dependence. However, almost one third of the current cannabis users in the study (31.7 per cent) met criteria for cannabis dependence and abuse [299, 300]. Similarly, among a group of French high school students who regularly or occasionally used cannabis, 47.2 per cent indicated substance dependence. Data concerning tolerance, withdrawal and excessive consumption indicated that subjects were significantly affected by their addictive behaviour. Among those having smoked for one year or less, 31.4 per cent reported signs of dependence versus 68.6 per cent who consumed on a recreational basis; among those having used cannabis for three years or more, 63.6 per cent reported dependence, while 36.4 per cent admitted to recreational usage [301]. In an Australian study of a sample of long-term cannabis users, more than half received a dependence diagnosis on each of three measures in the past year, and 44 per cent had a diagnosis of dependence on all three examinations. Longitudinal analyses revealed that quantity of use and severity of dependence at baseline were the primary predictors of those same variables at follow-up. These data suggest that cannabis use and dependence are fairly stable among long-term users [302].

As previously mentioned, case reports and laboratory research indicate the existence of a cannabis withdrawal syndrome. Wiesbeck and others analysed data from 5,611 subjects through the Collaborative Study of the Genetics of Alcoholism. Almost 16 per cent of the more frequent cannabis users related a history of a cannabis withdrawal syndrome. Even when alcohol and drug use patterns were statistically taken into account, cannabis use was still significantly related to self-reporting of a history of cannabis withdrawal. The typical withdrawal symptoms included "nervous, tense, restlessness", "sleep disturbance" and "appetite change" [303].

Another study found that two thirds of cannabis-dependent patients reported withdrawal symptoms on cessation of use. Progression from first to regular cannabis

*Alcohol is included in the calculations when it was included by the Member State in the breakdown of the national treatment population and for all Southern African countries. Unspecified substances, "other drugs" and "multiple drugs" (which could include cannabis) were excluded from the calculations.

use was as rapid as tobacco progression and more rapid than that of alcohol, suggesting that cannabis was a reinforcer. The data indicated that for adolescents with conduct problems, cannabis use was not benign and that the drug potently reinforced cannabis-taking, producing both dependence and withdrawal [304]. A review of the actions of cannabis on the brain reward circuitry also showed that THC had effects on core brain reward circuits that were fundamentally similar to those of other abused drugs, although the exact mechanisms may differ [292].

Budney and others, in a review of the validity and significance of a cannabis withdrawal syndrome, propose the following cannabis withdrawal syndrome criteria: common symptoms are anger or aggression; decreased appetite or weight loss; irritability; nervousness or anxiety; restlessness; and sleep difficulties, including strange dreams. Less common symptoms are chills, a depressed mood, stomach pain, shakiness and sweating [305].

The time course and clinical importance of withdrawal symptoms following cessation of heavy cannabis use have been reported by Budney and others. A 50-day outpatient study assessed 18 cannabis users during a 5-day smoking-as-usual phase followed by a 45-day abstinence phase. Onset of withdrawal symptoms typically occurred between the first and third days, peak effects between the second and sixth days and most effects lasted 4-14 days. The magnitude and time course of these effects appeared comparable to tobacco and other withdrawal syndromes [306].

In contrast to these findings, Smith, after reviewing the published literature on cannabis withdrawal symptoms in human users, concluded that the studies conducted up to that point in time did not provide strong evidence for the drawing of any conclusions about the existence of a cannabis withdrawal syndrome in human users, arguing that cannabis did not provide as clear a withdrawal pattern as other drugs of abuse, such as opiates [307].

Prenatal exposure to cannabis

WHO points out that research in this area is complicated by sampling issues and questionable self-reported data. Despite these, they conclude that there is reasonable evidence that cannabis use during pregnancy leads to reduced birth weight, possibly due to the same mechanism as tobacco smoking, foetal hypoxia. They conclude that there is little evidence to support the idea that cannabis smoking causes chromosomal or genetic abnormalities or birth defects.

The results of the Avon Longitudinal Study of Pregnancy and Childhood in over 12,000 women (5 per cent of whom reported smoking cannabis before and/or

during pregnancy) suggest that the use of cannabis during pregnancy was not associated with increased risk of perinatal mortality or morbidity. However, frequent and regular use of cannabis throughout pregnancy may be associated with small but statistically detectable decrements in birth weight [308]. These results correlate with previous findings that cannabis use in pregnancy is associated with reduced birth weight [309, 310, 311] and length at birth [312]. Furthermore, as indicated by Fried and colleagues, although a smaller head circumference observed at all ages reached statistical significance among the early adolescents born to heavy cannabis users, prenatal exposure to cannabis was not significantly related to any growth measures at birth [313].

Most studies have confirmed the WHO conclusion by finding no relationship with either minor or major morphologic abnormalities [314]. However, the Atlanta Birth Defects Case-Control Study comprised 122 isolated cases of simple ventricular septal defects and 3,029 control infants born during the period 1968-1980 in the metropolitan Atlanta area in the United States. Data on alcohol, cigarette and illicit drug use were obtained through standardized interviews with mothers and fathers. A twofold increase in risk of isolated simple ventricular septal defects was identified for maternal self- and paternal proxy-reported cannabis use. Risk of isolated simple ventricular septal defects increased with regular (three or more days per week) cannabis use. This is the first study to identify an association between maternal cannabis use and ventricular septal defects in offspring [315].

Three case-control studies have found associations between cannabis use during pregnancy and increased risk of cancer in children. The mothers of children with acute non-lymphoblastic leukaemia were 11 times more likely to have used cannabis before and during pregnancy than were mothers of controls [316]. Two case-control studies have reported an increased risk of rhabdomyosarcoma [317] and astrocytomas [318] in children born to women who reported smoking cannabis during pregnancy. However, neither study was a planned investigation of the association between these childhood cancers and maternal cannabis use.

Mild but significant cognitive impairments in the offspring of mothers who smoked cannabis during pregnancy were found in the Ottawa Prospective Prenatal Study [319]. These data were confirmed through other studies. Prenatal cannabis use was significantly related to increased hyperactivity, impulsivity and inattention symptoms at age 6 [320] and age 10 [321, 322]. Furthermore, it had a significant effect on academic performance: learning and memory of 10-year olds [322] and deficits in reading, reading comprehension, spelling and overall lower rating on the teachers' evaluations of the children's performance [323].

A follow-up study by Fried and others of the same group between the ages of 13 and 16 years indicated that those who had been exposed to cannabis in utero had poorer performance on tasks involving visual memory, analysis and integration [275].

Cannabis smoking and the lungs

As WHO has concluded, smoking cannabis is not good for the lungs. Moreover, as cannabis smokers inhale more deeply, smoking a cannabis cigarette results in exposure to significantly greater amounts of combusted material per inhalation than smoking a tobacco cigarette. Of course, most cannabis users consume fewer cigarettes than most tobacco smokers, but this may not be the case with those classified as “chronic” consumers.

The histopathological effects of cannabis smoke exposure include changes consistent with acute and chronic bronchitis. Cellular dysplasia has also been observed, suggesting that, like tobacco smoke, cannabis exposure has the potential to cause malignancy. In addition, in many parts of the world, cannabis is consumed with tobacco. Almost all studies indicate that the effects of cannabis and tobacco smoking are additive and independent [324].

Daily herbal cannabis smoking has been clearly shown to have adverse effects on pulmonary function and produce respiratory symptomatology (coughing, wheezing and sputum production) similar to that of tobacco smokers [325]. Several studies have demonstrated that, after even limited exposure to cannabis smoke, airway inflammation develops. Examination of the lungs of cannabis smokers who smoked an average of only a few cannabis cigarettes per day showed the same degree of airway injury as that detected in tobacco smokers who smoked 20 to 30 cigarettes per day. This underscores the importance of deep inhalation in enhancing the relative injury caused by cannabis smoke [326].

Cannabis smoke is also a potential cause of cancer because it contains many of the same carcinogenic substances as cigarette smoke. A review of the basic science work concluded that the evidence clearly demonstrated the ability of cannabis smoke to produce mutations and cancerous changes [327].

In a case-control retrospective study of 173 previously untreated cases with carcinoma of the head and neck and 176 cancer-free controls, the relationship between cannabis use and head and neck cancer was investigated. The risk of cancer was 2.6-fold greater in cannabis smokers than in non-users. Strong dose-response relationships were observed for frequency of cannabis use and years of cannabis use. Furthermore, the effects of cannabis use and tobacco smoking were more than multiplicative [328].

In a review of all of the current evidence, Hall and others conclude that there are good grounds for believing that chronic smoking of cannabis carries a significant risk of cancer in the aero-digestive tract and lung [329]. Other recent research, however, does not appear to support that conclusion.

It is also believed that cannabis use compromises the immune system. Cannabis smoke impairs the functioning of alveolar macrophages, the first line of the

body's immune defence system in the lungs. Alveolar macrophages from cannabis smokers are severely limited in their ability to kill both bacteria and tumour cells. The ultimate outcome of these effects may be an enhanced susceptibility to infectious disease, cancer and HIV/AIDS [330]. However, there is as yet no epidemiological evidence that rates of infectious disease are increased among chronic heavy cannabis users. Several large prospective studies of HIV-positive men who have sex with men have not found that cannabis use increases progression to AIDS [331].

Cannabis and the heart

Acute cardiovascular effects of cannabis are dose dependent tachycardia, which can lead to increased cardiac output and is generally associated with a mild increase in blood pressure. At high doses, sympathetic activity is inhibited and parasympathetic activity increased, leading to bradycardia and hypotension [332].

The cardiovascular effects of cannabis are not associated with serious health problems for most young, healthy users, although occasional myocardial infarction, stroke and other adverse cardiovascular events are reported. Cannabis smoking by people with cardiovascular disease poses health risks because of the consequences of the resulting increased cardiac work, increased catecholamine levels, carboxyhemoglobin and postural hypotension [333].

Smoking cannabis has been shown to be a rare trigger of acute myocardial infarction. This was observed in the Myocardial Infarction Onset Study. Of the 3,882 patients, 124 (3.2 per cent) reported smoking cannabis in the prior year of myocardial infarction symptoms. Compared to the patients who were not cannabis users, the users were more likely to be males, cigarette smokers and overweight. The risk of myocardial infarction onset was nearly five times as high as baseline within one hour after smoking herbal cannabis. The elevated risk rapidly decreased thereafter [334].

Cannabis is not "harmless"

As noted previously, the fact that the therapeutic effects of cannabis are being researched and legal changes are being made to accommodate this work may have obscured one simple fact: cannabis use is not good for your health.

- According to a number of studies and many users, cannabis smoking impairs one's ability to drive a car safely and perform complex operations requiring motor skills.
- A significant share of cannabis users (about one fifth, according to one study) have experienced unwanted psychic effects during cannabis intoxication, including panic attacks, paranoia and "psychotic symptoms",

and the risk of this happening may be increased by the growing availability of high-potency cannabis.

- Numerous studies find an association between cannabis use and psychosis and this effect is also likely to be influenced by the potency of the cannabis consumed.
- Despite early claims to the contrary, cannabis dependence is a reality: many people who consume cannabis (several studies indicate just under 10 per cent) find it difficult to stop, even when it interferes with other aspects of their lives, and more than one million people from all over the world enter treatment for cannabis dependence each year.
- Research indicates that younger users, whose brains are still developing, may be especially vulnerable to the negative effects of cannabis.
- Cannabis smoking is bad for the lungs for all the same reasons that tobacco smoking is.
- There appear to be significant risks associated with prenatal exposure to cannabis and the effects of cannabis on the cardiovascular system.

Whether these negative effects are greater or lesser with cannabis than with other substances, including legally available substances, is of little relevance to the users whose lives are affected by them. Despite its normalization in some countries and its celebration in popular culture, it should be noted that cannabis is a powerful drug that has recently become more powerful in many parts of the world.

It would be an error to generalize the experiences of the well-educated, upwardly mobile cannabis-smoking generation of the 1970s to the broader world today. Users today in many parts of the world are starting younger and consuming cannabis of much higher potency than in the past. In developing countries, they may see few more attractive alternatives to the positive feelings induced by the drug. The risks of substance dependence in this context are qualitatively different to those experienced in some countries where cannabis use has become a “rite of passage” today.