
Many misconceptions regarding marijuana pervade (and misconstrue) the narrative about both its hazards and potential benefits. While marijuana remains on Schedule 1 of the federal Controlled Substances Act, a number of state-level laws have recently been adopted that are changing the policy landscape. However, these changes in law are not always informed by decades of accumulated scientific knowledge. A well-balanced, science-informed national marijuana policy would balance risks that exist both for policies that are too restrictive and too permissive.

On the one hand, decades of order maintenance policies that accompanied the drug war have decimated communities through mass incarceration, significantly and unevenly affecting people of color due to persistent structural racism in our society. Also, strict prohibition policies in many states have sweeping effects on the availability of medical marijuana and its nonaddictive components, limiting their access for patients with pain, cancer, multiple sclerosis, and other diseases who could otherwise benefit from medicalized marijuana’s ameliorative properties (Harvard Health Publishing).

On the other hand, current-day more permissive drug laws are associated an increasing number of adolescents who perceive recreational marijuana use as harmless, despite scientific evidence (cited below) that heavy, chronic use in adolescence is detrimental to their development and both physical and mental health. Furthermore, there appears to be a growing national trend across all age groups reflective of the view that marijuana is not harmful, as we see a significant uptick in several serious negative consequences, such as increases in prenatal exposure, unintentional childhood exposure, and marijuana-related car accidents in adults but particularly among teenagers (Hassin et al., 2018).

Incorporating existing science into the policy narrative promises to provide critical opportunities to make course corrections.

Since the default marijuana policy position for states and the federal government has been in favor of prohibition, we first describe both the benefits of marijuana use and the benefits of the end of prohibition. We then turn to adverse health effects which must be addressed in any government where marijuana is not prohibited. We conclude with recommendations for policy.

The End of Marijuana Prohibition

Marijuana benefits can generally be grouped into two categories: benefits from expanded use of marijuana and benefits from the end of prohibition.

Marijuana’s Health Benefits as Medicine
The potential health benefits of marijuana are becoming increasingly apparent, however, not all components of marijuana are equal in that regard. In fact, there are several compounds in the marijuana plant that exert very different effects. THC is the psychoactive ingredient that produces a “high”; hence, its use for recreational purposes. Two synthetic versions of THC with fewer psychoactive effects have been FDA approved to prevent nausea and vomiting in chemotherapy patients. Prescriptions for these synthetic medications are increasingly common due to their effectiveness. Cannabidiol (CBD) is another compound in marijuana that has no psychoactive properties (i.e., it does not produce a “high) and is thought to be responsible for the majority of the medical benefits. For example, CBD has been shown to improve pain and inflammation, reduce symptoms of mental illness (e.g., anxiety, depression and addiction), epileptic seizures and autoimmune disorders, and there is some very preliminary evidence that it may even kill some types of cancer cells and protract its spread. Hundreds of studies are currently underway to investigate the medical uses of CBD and determine whether potential side effects may outweigh the benefits.

There are other potential benefits from the use of THC-rich marijuana, despite its psychoactive properties. For example, because it has proven useful for pain relief, THC may be used in conjunction with opiates and opiate analogs, reducing the need initially for more physically addictive substances (Wen & Hockenberry, 2018). There are even suggestions that THC might replace opioids for pain control or could supplement opioids to curtail the amount of opioids needed for pain relief (Lucas & Walsh, 2017). It may also help individuals suffering from drug dependence to wean themselves from opioids (along with other primary treatments) and, at the same time, reduce symptoms of mental health disorders that are prevalent among individuals with addiction (Elikottil et al., 2013). An important caveat is that we need to be cautious about substituting one dependence-producing compound for another, in this case THC. Most would agree, however, that marijuana is infinitely less harmful—although not without risk particularly in adolescence as discussed below—in that it is not as powerfully addictive and has not gripped the nation in the way opioids have, with the dramatic increase in addiction and massive overdoses.

**Benefits from the End of Marijuana Prohibition**

In general, the motivation for criminalizing marijuana use is to reduce criminal offending from those who are under the influence and offending associated with marijuana trafficking (MacCoun and Reuter, 2001). When users are ‘high’, impulse control is reduced and offending is more likely (this is commonly referred to as the psychopharmacological effects of marijuana use). In addition, marijuana users may seek to illegally obtain money to support their habits (this is generally referred to as economic compulsive crime). Third, drug trafficking networks are notoriously violent with a combustive mix of illegal weapons, high value products, intoxicated market participants and a lack of legal protections to protect property rights. Most drug policy experts conclude that a removal of marijuana prohibitions would substantially reduce these harms (Kleiman, 1993).

We first consider the costs of marijuana use that would remain after the end of prohibition, and then turn to the benefits of moderating prohibition.

**Social Costs of Marijuana Use**

Most of the evidence supporting criminalization focuses on the immediate psychopharmacological effects of consumption (of being ‘high’) and social costs of drug trafficking. As noted, the immediate effects of marijuana consumption include impairment of attention, abstract reasoning, concentration, decision-making, inhibition, impulsivity, and working memory during use and shortly thereafter (Crean et al. 2011). Increased risk of mortality and morbidity from motor vehicle accidents has large social costs (NHTSA, 2017).
There is also a risk of more serious, but quite rare, overdose events (not associated with death) (CDC 2018).

As detailed in the Report of the Johns Hopkins – Lancet Commission on Drug Policy and Health, 2016, similar to any other prohibited economic good, criminalization of marijuana creates illegal or black markets. Marijuana trafficking markets historically and today contain many of the socially costly features of Schedule 1 narcotic trafficking markets. Organized criminal enterprises exist at all levels of distribution: cultivation and manufacturing, wholesale distribution, and retail sales. As marijuana is typically domestically sourced, some of the socially costly features of transnational crime are reduced, but drug trafficking costs are high with respect to violence and disorder. Violence occurs routinely between rival criminal enterprises, within criminal enterprises, and between the criminal enterprises and consumers, especially in open air drug market settings. Profits from marijuana drug trafficking support other organized criminal activity including gang violence, weapons, human trafficking and trafficking in narcotics.

Drug-seeking behavior—often referred to in drug policy circles as ‘economic compulsive’ behavior—includes criminal activity to obtain resources to buy marijuana. Although typically less consequential than economic compulsive behavior around other Schedule 1 drug acquisition, marijuana drug seeking behaviors contribute to other criminal activity, in particular retail drug trafficking. For women, allied criminal activity typically includes shoplifting, other theft and prostitution. For men, related criminal activity more often includes burglary and robbery. Despite these concerns, serious person crimes such as assault may be reduced while users are actively high due to the ‘amotivational syndrome’ of marijuana consumption.

Criminal Justice Responses and Decriminalization/Legalization
Prohibition of marijuana has been a costly failure (Drug Policy Alliance, 2018), contributing in our history to mass incarceration, militarized policing, and disruption of communities and family structures. Close to a million people each year are processed by the criminal justice system (CJS) for violating marijuana laws. Although only a small percentage arrested for simple marijuana possession are ultimately convicted and incarcerated for that crime alone—consequences largely reserved largely for sales and distribution—marijuana policing explains much of the initial contact with the system (FBI, 2016). Such remedies have not served to reduce marijuana use, constrain availability or reduce the hazards associated with its use. Rather, none of these goals have been achieved via prohibition laws and CJS responses. And importantly, CJS’s responses are disproportionately targeted, with people of color and the poor more often arrested and convicted, even though marijuana consumption is less prevalent in these communities (Mauer, 2011). This scenario translates to a huge disconnect between extent of use in this population and CJS response. As such, the magnitude of funds allocated to marijuana possession by the CJS, mental health services, and other agencies, along with the expenditures associated with inequities in their distribution, are enormously and unjustifiably costly to the taxpayer.

Adverse Health Effects
Among drug policy researchers, the adverse health effects of marijuana use are divided between psychopharmacological effects, which are conventionally described as the act of getting and being high, and the long term effects of use, both in the near term and persisting over the life course (Volkow et al., 2014). Short- and long-term health consequences are discussed below, followed by a discussion of the psychopharmacological effects of use and the attendant criminal justice policy responses.
The National Academies of Sciences released an extensive review of the evidence on the health effects of marijuana in January 2017. The Academy structured its review based on the strength of the evidence for each health effect. “Substantial evidence” was defined as the existence of several high-quality studies supporting a particular effect with few or no credible conflicting studies. And “moderate evidence” was defined as several good to fair-quality studies supporting a particular effect with few or no credible conflicting studies (NAS, 2017).

A finding of a number of negative physical health effects (including exposure during pregnancy to adult use) were supported by substantial evidence (NAS, 2017). For example, moderate to substantial evidence were found for:

- Lower birth weights among infants of women who used marijuana during pregnancy.
- More frequent episodes of bronchitis and more severe respiratory symptoms among regular users.
- Increased contemporaneous risk of motor vehicle accidents with marijuana use.
- An increase in overdose injuries among children in localities where marijuana has been legalized.

The National Academy report also documented a number of negative impacts of marijuana use on mental health outcomes, including psychosocial development in adolescence, described in greater detail in the following section on Adolescent Health Effects (Hall & Degenhardt, 2009). These include moderate to substantial evidence for associations between marijuana use and:

- The development of schizophrenia and other psychotic disorders.
- A number of other mental health problems, including increased symptoms of mania and hypomania in individuals with bipolar disorder, increased risk for disordered use of alcohol, tobacco, and other illegal drugs, and increased incidence of social anxiety disorder.
- Increased incidence of suicidal ideation, attempts, and completion, as well as a small increase in risk of depressive disorders (NAS, 2017).

Marijuana has also been associated with alterations in reproductive systems, both developmentally and functionally:

- In females, marijuana use can disrupt the menstrual cycle, suppress the production of mature egg cells, and impair embryo implantation and development (Bari et al., 2011).
- In males, marijuana use can lead to ejaculation problems, reduced libido, and impotence (Bari et al., 2011).
- Marijuana also reduces sperm count and motility (Bari et al., 2011; Whan et al., 2006), with a reduction in sperm concentration by 28% and a reduction in total sperm count by 29% (Gundersen et al., 2015). Accordingly, men are instructed not to use marijuana before undergoing a sperm count test due to this effect, which is the result of THC’s suppression of testosterone, a male hormone that is responsible for masculinizing the brain’s and body’s anatomy.
- Heavy marijuana use in adolescent boys who are not yet reproductively mature may experience a delay in maturation of that system, negatively impacting reproductive potential (du Plessis et al., 2015).
A critical issue in marijuana policymaking is whether marijuana is addictive and/or leads to dependence. Extensive scientific research has determined that marijuana has addictive properties, activating several neurochemical “reward” centers in the brain, including the opioid system (Covey et al., 2015). The National Institute on Drug Abuse (NIDA) has determined that patterns of compulsive use and withdrawal symptoms develop in some regular users that resemble addiction (NIDA, 2018). And importantly, using marijuana significantly increases risk of using other substances and developing a substance use disorder (Blanco et al., 2017; Olfson et al., 2017).

Adolescent Health Effects
Teenagers are at heightened risk for experimenting with drugs in general, and earlier onset of use predicts greater risk for eventual dependence (Meyers & Dick, 2010). There is further evidence that marijuana’s regular use during adolescence leads to abuse and dependence at higher rates than alcohol (Cougle et al., 2016). The consequences of dependence appear to be most problematic in life functioning including serious problems at home, work, or school (Turner, 2014).

The brain is rapidly developing and increasing its efficiency during adolescence. In effect, the brain is vulnerable during this time to both positive and negative exposures that can alter the course of brain development and functioning (Andersen, 2003; Spear, 2013). For example, severe stress during adolescence has been shown to impair certain aspects of brain development and cognitive functioning (Pechtel & Pizzagelli, 2011; McEwen & Morrison, 2013). Thus, it is not surprising that regular marijuana use in adolescence has been associated with a number of developmental delays in neurological, cognitive, and psychological domains (Tapert et al., 2008; Harvey et al., 2009; Lisdahl et al., 2014; Lubman et al., 2015; Solowij et al., 2017; Gruber & Sagar, 2017). Moreover, studies of the developmental trajectories of heavy marijuana use throughout adolescence have identified deficits in cognitive function, including in children exposed in utero, and performance decrements in several aspects of daily living (Volkow et al., 2014). A selection of such findings include:

- Adolescents who use marijuana just once a week perform worse on measures of attention, abstract reasoning, spatial working memory, and learning than those who do not (Harvey et al., 2009).
- Occasional marijuana use during adolescence can impair attention, concentration, decision-making, inhibition, impulsivity, and working memory during use and shortly thereafter (Crean et al. 2011).
- Adult users who begin smoking in adolescence before age 17 show more significant impairments in these executive functions compared to those who begin after age 17 (Pope et al., 2003).
- Regular use (at least weekly) may also disrupt healthy neurodevelopment that should occur during adolescence (Lubman et al., 2015; Gruber & Sagar, 2017), especially in areas of the brain responsible for higher-order cognitive functioning (Lisdahl et al., 2014).

As cited above, heavy use of marijuana has been shown to stall development of vital reproductive systems during adolescence, leading to lack of maturation in areas of the brain responsive to testosterone, as well as problems with sexual performance. Although these effects are particularly consequential during adolescence and have an impact on many aspects development and functioning, there is a broad lack of awareness of these consequences (Bari et al., 2011).
Taken together, there is overwhelming evidence that adolescents may be more vulnerable to adverse health consequences of marijuana use than adults (Lisdahl et al., 2014; Lubman et al., 2015). If use is heavy and chronic, these impairments may not improve with abstinence, especially if use was initiated early in adolescence, before full maturation of higher order cognitive functions is achieved (Crean et al., 2011). Chronic, heavy use is also associated with a higher likelihood of unconventional behavior, sensation seeking, emotional dysregulation, alcohol dependence/abuse, and spouse/partner marijuana use in adulthood compared to those who discontinued use (Brook et al., 2016). Thus, the real concerns for teenagers are not death from overdose or development of chronic disease, but rather impediments to short and long term functioning and the habit-forming nature of this product.

**A Brief History of Marijuana Policy Reform**

In response to these social costs and disparities, the number of states and cities permitting (legalizing) medical marijuana and legalizing adult 'recreational' use is increasing, and the rate of use is rapidly accelerating (Hassin et al., 2018).

The legal landscape that emerged has followed an interesting pattern—over a dozen states have legalized medical marijuana, both through ballot measures and more recently through state legislatures. Some of these same states have taken additional steps to legalize ‘adult recreational use’ of marijuana, in some cases disadvantaging their original medical marijuana programs. Unless the federal government steps in by re-categorizing marijuana so that it is no longer a Schedule 1 substance with ‘no medical use’, this pattern is likely to continue.

The transition to legalized access to marijuana to varying degrees has included important barriers to implementation of such policies. Initially some state medical marijuana programs, especially California’s, have suffered from relatively lax or absent oversight, and numerous ambiguous legal issues (Caulkins, 2016). While regulatory fixes are underway for these state medical programs, such programs affect relatively few people compared to expectations for adult use legalization (Caulkins, et. al., 2016). The number of participants in state medical marijuana programs have generally been small, as doctor’s visits, recommendations, fees, and other requirements make participation costly.

Perhaps most important is the need to address the current inconsistencies across state and federal policies. These inconsistencies will continue unless a policy change at the federal level is instituted. Cannabis is once again on the ballot in the current election; Michigan and North Dakota will decide on the legalization of adult use, Utah and Missouri are considering medical marijuana legalization initiatives. Meanwhile, many voices within the medical cannabis community (see the Patients Out of Time web site) are suggesting ‘descheduling’ rather than rescheduling cannabis. Careful research on the responses from the FDA call for public comments on the international classification of cannabis and cannabinoids might prove fruitful. The recommendation is for the federal government to respond to these circumstances by fostering new, applied research programs and policies that will both respect what individual states have done and attempt to integrate coherent, evidence-based, policies to help reduce the current ‘states of confusion’. [A tall order!]

Comparisons between marijuana and alcohol are often made due to similar expectations for post-prohibition consequences. However, there are relevant distinctions that should be taken under advisement in formulating policy reforms for marijuana use. They are entirely different substances, used for different purposes, often by different people, and associated
with different harms and benefits. We should keep in mind that the use of alcohol, even with age and other restrictions, is associated with more injuries, crimes, violence and deaths from accidents and chronic disease than all other illicit drugs combined.

**Policy recommendations**

Formulating policies that are consistent with scientific evidence increases the likelihood that they will be effective, more beneficial, and less harmful to individual users, their families, and society-at-large. **In developing policy recommendations around marijuana decriminalization or legalization, we note that the costs and benefits should be weighed, while excluding the crime consequences of black markets, which decriminalization will specifically remove.** In any reasonable calculus, the majority of harms from marijuana consumption are the direct result of black market responses to criminalization. However, it is imperative that information regarding the full spectrum of adverse consequences and potential benefits of marijuana is accessible (1) to the public to make informed decisions regarding their own use, and (2) to lawmakers to formulate legislation that conveys the least harm and the most benefit to their constituents.

The overview presented herein can be distilled into four key messages:

- Policies, including both those enacted in the past and many of those being rolled out in real time, are not responsive to existing knowledge. As a result, in states that have legalized the recreational use of marijuana, marijuana-related emergency room visits have significantly increased and the number of arrests and car crashes related to driving under the influence of marijuana are edging up. Also, adolescents are reporting perceptions that the drug is “safe” or at least not hazardous or addictive. It appears that policies are changing attitudes in an unintended direction.

- Marijuana use in early adolescence is associated with more severe adverse consequences than onset later in adolescence or in adulthood.

- There are grave risks involved with maintaining marijuana’s criminalization at all costs. Decriminalization has potential to bring its distribution and use “above ground”, reducing opportunities for gangs, violence, contaminated supplies, and other adverse consequences.

- Medical research is unveiling several advantages to medicalizing marijuana, particularly CBD, a non-psychoactive component that may reduce pain, increase appetite, control seizures, and alleviate a variety of other ailments. Policy decisions regarding medicalized marijuana should not be swayed by outdated and inaccurate preconceptions.

These research findings reflect the complexities of the question as to whether and how to roll out policy reforms and clearly indicate that the decision making process around these issues needs to be probing, in depth and conscientious. Several policy recommendations are offered here for consideration:

1) Invest resources in delaying the age of initiation of marijuana use past the age when the brain is still under construction (~age 25) to reduce impact on neurodevelopment and avoid this period of heightened reward sensitivity. Thus, risk for addiction would be decreased and the cascading negative effects on health outcomes would be prevented.

2) Support screening, early detection and intervention. Focus both on at-risk youth who have not yet initiated to avert pathways to use in adolescence and youth who have already begun using marijuana to avoid negative consequences including the escalation of use into dependence/addiction.

3) Promote a detailed, comprehensive, scientific review of the current panoply of laws surrounding both
medical cannabis and adult use (legal) cannabis. If the (suggested) goal is to reduce inconsistencies and confusion surrounding the legal status of cannabis, we need to recognize what has already been done, and how it is working (or not working) to offer relevant suggestions for future legislation.

4) Update the regulatory structure to keep pace with commercialization by applying uniform standards on the types of products that can be sold or marketed to the public (Reuters, 2017).

5) Increase availability of CBD for medical use with the appropriate physician or psychiatrist supervision in cases of serious medical and mental health conditions.

6) Reduce stigma for both recreational users and patients by disseminating knowledge regarding its social, psychological and pharmacological effects, thereby taking substance abuse and dependence out of the moral realm.

7) Recategorize marijuana from Schedule I to Schedule III or IV to be more consistent with its known pharmacological properties and effects, having potential for moderate physical and psychological dependence and currently accepted medical use in the U.S.

8) Invest in research and increase access to marijuana by investigators seeking to better understand the impact of the different components, types and dosages of marijuana on risk for addiction and effects on neurodevelopment in adolescence. Preliminary evidence suggests that higher levels of CBD and lower levels of THC may improve the public health impact of marijuana use. (See Lisdahl et al., 2014). This pursuit could eventually lead to FDA guidelines on limits for THC content in recreational marijuana. Equally important is research to determine subgroup differences; most users do not use frequently or continue over the life course. To effectively target our precious resources, it is critical to identify the risk factors that account for the subgroup that constitutes an overwhelming majority of regular and heavy users. We need to understand the difference between individuals who follow different drug use pathways. And we need to determine what protective factors are at work to avert these pathways so we can strengthen them through well-designed interventions and broad policies.

9) Fund and widely implement a high quality public education campaign to inform youth, parents, adults who work with youth, and healthcare providers about the dangers of marijuana use during childhood and adolescence.

Conclusion

Marijuana has a history replete with ill-informed notions about its effects and the individuals who use it (MacDonald & Pappas, 2016). Fortunately, recent decades have seen a significant progression of marijuana research and, as a result, a substantial body of evidence on marijuana has been amassed that should guide our decision-making on many levels. It is increasingly clear, however, that there are two sides to this coin. On the one hand, we have a better grasp of the risk for addiction, mental health and reproductive disorders and compromised immune system responses associated with marijuana use (Volkow et al., 2014). And on the other hand, CBD has emerged as an effective medical treatment without the psychoactive and adverse health consequences of THC and its consumption. Also, the societal costs of prohibition can be better anticipated. As such, removing marijuana prohibitions will lead to both considerable social costs and benefits, which can now be more accurately anticipated using existing scientific evidence. Careful consideration of these contrasting consequences—that differ by age, purpose for use, and circumstances—can ensure effective policy making that benefits millions, both with the removal of policies with no scientific basis and the adoption of thoughtful reforms (See Ammerman et al., 2014 for policy review).

National Prevention Science Coalition to Improve Lives (NPSC)
**Authors:**
Diana Fishbein, Ph.D., Professor and Program Director, The Pennsylvania State University and Co-Director of the NPSC.
John Roman, Ph.D., Senior Fellow, NORC, University of Chicago and Co-Director of the NPSC.
Elizabeth Long, Ph.D, Postdoctoral Scholar, Edna Bennett Pierce Prevention Research Center, Pennsylvania State University
Alan Lehman, Ph.D., Senior Lecturer, Department of Criminology and Criminal Justice, The University of Maryland, College Park
Sharon Kingston, Ph.D., Associate Professor of Psychology, Dickinson College and Secretary of the NPSC.