Is Marijuana Safer than Alcohol?
Insights from Users' Self-Reports

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Executive Summary
Both marijuana and alcohol are dependence-inducing intoxicants that bring pleasure to most users but causes a range of physical, mental, and behavioral harms to others, including harms borne by the users themselves, by their family and friends, and by society more generally (Edwards et al., 1994; Volkow et al., 2014). To borrow Tom Babor's phrase, neither is an ordinary commodity (Babor et al., 2010).

Yet policy treats them very differently in the United States. Federal law prohibits marijuana; alcohol has been legal for over 80 years. Support for legalizing marijuana has grown sharply, and comparisons with alcohol are common (Caulkins et al., 2012). In particular, those favoring legalization often argue that marijuana is safer than alcohol (e.g., Rifle, 2013; Fox et al., 2013).

Alcohol is certainly more dangerous in some respects, including sole-cause acute overdose deaths, accidents, and violence. But risk is multi-faceted, and this paper demonstrates that marijuana is the riskier substance with respect to other important outcomes.

Over the past 30 years, household surveys in the United States have asked parallel questions of marijuana and alcohol users concerning whether their substance use has caused them problems. For each pair of questions, the number of "yes" answers per past-month user is computed. For example, one pair asks whether use of each substance created serious problems at home, work, or school. For every 100 past-month users of alcohol, three reported that alcohol caused them serious problems at home, work, or school. By contrast, for every 100 past-month marijuana users, eight said marijuana caused such problems.

Those absolute rates may be affected by under-reporting and sample selection bias, but the relative magnitude of the marijuana vs. alcohol rates provides a unique window into the riskiness of the two substances, not in an artificial laboratory sense, but as the substances are actually used. For the question about creating problems at home, work, or school, that eight to three ratio becomes, to two digits of precision, 2.8 to 1.

The relative rates vary by question from somewhat below 1.0 to as high as 4.5, but most are between 1.5 and 3.0, suggesting that marijuana as used in the U.S. has been about 1.5 to 3.0 times more likely to generate problem reports among its users than has alcohol. Marijuana appears riskier on questions that inquire about ability to fulfill functional life roles; alcohol matches and sometimes exceeds marijuana on questions that pertain to physical safety.

Note: these are not individual-level risk ratios controlling for covariates, but average rates reflecting historical patterns of use. Marijuana users tend to be younger and less well educated than alcohol users, which may make them more vulnerable; conversely, alcohol users have, on average, been using longer and so had more time for abusive use patterns to develop. Furthermore, legalization could alter patterns of use for marijuana (and perhaps alcohol too), which could alter these ratios.

Since 2000 the questions have been designed to support an assessment of whether the respondent meets the criteria for substance abuse or dependence defined by the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV). In every year from 2000 – 2012 the number of respondents judged to meet DSM-IV criteria for marijuana dependence per past-month user was 2.3 – 3.3 times as high as the corresponding rate of dependence per past-month alcohol user.

A special supplement in 1996 examined self-reported rates of impaired driving. Marijuana users reported two to three times as many instances of impaired driving per past-month user who drove as did alcohol users. Most who reported driving while marijuana-impaired also reported instances of driving within two hours of concurrent use of both alcohol and marijuana.

These observations complement previous comparisons of harms across substances, most of which drew on experts' judgments (e.g., Nutt et al., 2007, 2010; Bourgain et al., 2012; van Amsterdam et al., 2010, 2013). Non-experts' perceptions of risks can differ from those of experts in general (Slovic, 2000) and with respect to drugs' harms (Reynaud et al., 2013). Other studies of non-experts have polled the general public including non-users (Calabria et al., 2012; Reynaud et al., 2013) or polled users who were recruited from drug-oriented websites (e.g., Morgan et al., 2010, 2013). Here, the respondents are a representative sample of all users, and they were asked to identify the problems they themselves experienced, not to speculate abstractly about typical harms for some notional average or representative user.

These results should not be construed as implying that marijuana is more dangerous than alcohol; indeed, any scalar summary measure and associated ranking of drugs' overall dangers is simplistic to the point of being potentially misleading (cf. Kalant, 1999; Caulkins et al., 2011).

Rather marijuana and alcohol are each dangerous in different ways, to a greater or lesser extent. This has implications for prevention messaging and for policy, including not only the debate about *whether* marijuana should be legalized but also, if so, then *how*. E.g., it might bear on preferences concerning who should be allowed to produce and sell marijuana (e.g., for-profit corporations or just co-ops or non-profits), and how those operations should be regulated.

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1.0 Introduction

1.1 Context and Relevance

Marijuana advocates have long claimed marijuana is safer than alcohol (e.g., Rifle, 2013; Fox et al., 2013).[1] That view has become widely accepted; 73% of respondents to a recent CNN poll (2014) said alcohol was more dangerous than marijuana. It has even been endorsed by some public officials. This report shows that view is at best an oversimplification.

There are clearly ways in which alcohol is more dangerous; for example, the risk of fatal overdose is high for alcohol and near-zero for marijuana (Gable, 2004).[2] However, as shown below, marijuana users are substantially more likely to say that their marijuana use caused serious problems fulfilling responsibilities at work, home, or school. Likewise, rates of dependence per past-month user are several times higher for marijuana than for alcohol.[3]

Remnick (2014) quotes President Obama as saying that he doesn't "think it [marijuana] is more dangerous than alcohol" and may be less dangerous "in terms of its impact on the individual consumer" even though "it's a bad idea, a waste of time, and not very healthy." The President's more nuanced answer may come closer to capturing the truth although, given the results presented here, a still better answer would be: "alcohol is riskier than marijuana in some respects, and marijuana is riskier than alcohol in others."

In particular, respondents in nationally representative surveys consistently report more problems caused by marijuana use than by alcohol use, on a per user basis. Alcohol is used more widely, so more respondents report alcohol-related problems in total, but marijuana generates more reports of problems on a per-user basis.

The outcomes for which marijuana appears riskier run the gamut from interference with work, school, or family obligations to muddied thinking to anxiety and other mental health problems. There were domains for which there was no difference or, in some survey years, alcohol even appeared riskier, including causing arguments or fights. However, for the majority of outcomes about which the surveys inquired, marijuana use appeared to generate harms at a greater rate.

These findings are relevant for prevention. There is long-standing belief rooted in part in Monitoring the Future Studies of American youth (Bachman et al., 1990, 1998; Bachman, 1994;

[1] There is even an organization – SaferChoice.org – that is entirely devoted to promoting this view: http://archive.saferchoice.org/content/view/24/53/.

[2] Note: Although the risk of single-cause acute poisoning is almost incalculably higher for alcohol than for marijuana, it is not so high in absolute terms. The 1,647 acute poisoning deaths in the U.S. from alcohol alone pose a lower death risk per drinker than is the death risk per walker from pedestrian accidents. (1,647 deaths translates to 0.95 deaths per 100,000 past-year drinkers, whereas the 4,280 pedestrian deaths in 2011 spread over the nation's 311.6 million people works out to 1.37 pedestrian deaths per 100,000 walkers.) There were another 8,404 acute poisoning deaths due to multiple substances that were attributable to alcohol, but the "marijuana is safer than alcohol" argument usually focuses on effects of that substance alone, since marijuana can also contribute to deaths via interactions. And even the total alcohol-attributable poisoning death rate of 5.81 per 100,000 past-year drinkers is only half the 11.7 traffic deaths per 100,000 Americans. Acute toxicity is an important but not overwhelming consideration, as is apparent from the fact that so many people continue to choose to drink.

[3] Dependence is assessed in these data via numbers of various types of problems reported; problems with police or the law are not included in this list, so marijuana legal status does not bear directly on the dependence assessment.

Terry-McElrath et al., 2008) that perceptions of riskiness influence rates of use. The greater the perceived riskiness, the lower are rates of use and vice versa. Insofar as that theory is valid and conventional wisdom understates marijuana's risks, correcting those misperceptions might aid drug prevention efforts and reduce use-related harms.

At the societal level this report is timely because marijuana policy is in flux. Many states have decriminalized possession of small amounts, and 23 states and the District of Colombia have some form of medical marijuana law.[4] Of greater consequence in the long-run, voters in Colorado and Washington State have approved legalization of large-scale, for-profit commercial production and distribution of marijuana for use not just by those possessing a medical recommendation but by anyone over the age of 21 (what is customarily, though somewhat misleadingly, called "recreational" use). Despite some bureaucratic delays and the fact that all such activity remains illegal under federal law, there are now companies producing and selling marijuana to all-comers in both states. Alaska and Oregon are considering similar propositions this year (2014), Washington D.C. residents will vote on a more limited legalization of home production for personal use, and other states are expected to follow in 2016.

One argument for legalizing marijuana is that it is inconsistent to ban a substance that is less dangerous than another that is legal (Room, 2006; Nutt et al., 2007, 2010). Strictly speaking, enforcing such consistency will not necessarily improve societal welfare (Caulkins et al., 2011; Rolles and Measham, 2011). Appendix A explains why with a stylized example. Furthermore, the very fact that alcohol is blamed for killing 88,000 Americans a year can be seen as an argument against treating marijuana like alcohol, not as a ringing endorsement of the wisdom of allowing for-profit companies to promote consumption of dependence-inducing intoxicants. As Kleiman (1992) argues, invoking alcohol would be a more powerful argument for legalizing marijuana if we were doing better job of dealing with legal alcohol.[5]

A more practical basis for policy-making is to ask what makes society better off, and so whether the savings from not having to enforce a strict prohibition are offset, or more than offset, by the costs of greater use, abuse, and dependence. While it seems clear that overall marijuana use tends to be higher in states that have liberalized their marijuana policies (Wall et al., 2011; Cerdá et al., 2012) opinion is divided as to whether that association is more likely to be causal (e.g., Salomonsen-Sautel et al., 2014; Schuermeyer et al., 2014) or spurious (e.g., Harper et al., 2012; Lynne-Landsman et al., 2013).

The goal here is not to rehash the legalization debate. As Pacula and Sevigny (2014) argue, it is too early to assess the results of the policy changes to date, and various books already discuss the topic (e.g., Hall and Pacula, 2003; Room et al., 2010; Caulkins et al., 2012; Rolles and Murkin,

[4] Medical marijuana laws vary greatly. Some provide access only for people with serious diseases. In other states, medical marijuana turned into a form of quasi-legalization with most who obtained medical recommendations being young men in reasonably good health who complained of vague or easy-to-fake conditions such as anxiety or generalized pain. (There are also laws that allow CBD to be used to treat seizures; while marijuana contains CBD, THC not CBD is the chemical primarily responsible for marijuana's intoxicating and dependence-inducing effects. So CBD-oriented laws belong in another category altogether.)

[5] Of course someone might argue that consistency demands that marijuana be treated the same as alcohol even if that would make society less well off, but that is not how the consistency argument is usually framed.

2013). Rather, this report focuses more narrowly on the question: Is marijuana safer than alcohol on every important dimension? It concludes that the answer is "No."

1.2 Principal Finding

A simple statement of the empirical finding here is that while marijuana may be safer than alcohol in some respects, there are important dimensions along which marijuana appears to be the riskier substance. So universal statements about one substance being safer than the other ought to be avoided, since they necessarily depend on the observers' subjective weighting of the relative importance of these different dimensions.

Harmfulness is intrinsically a multi-dimensional construct. There are different types of harms (e.g., those stemming from intoxication vs. those stemming from long-term exposure), and different substances have different profiles across these different types of harms.

There has been considerable enthusiasm among certain academics for trying to reduce harmfulness to a single summary score on an aggregate scalar metric, and to presume that policy can be, indeed ought to be, driven by that number (e.g., Room, 2006; Nutt et al., 2007, 2010). This quest is full of pitfalls (Caulkins et al., 2011; Rolles and Measham, 2011), as can be appreciated by asking whether heroin or tobacco is more dangerous.

Heroin creates a very high risk of death from acute overdose. Cigarettes do not; death from acute cigarette poisoning is extremely rare.[6] However, prolonged cigarette use creates enormous harm (e.g., from lung cancer), whereas prolonged use of pharmaceutical-grade heroin has few such adverse effects. (People dependent on street heroin are generally in poor health, but that is primarily because they are poor, because they inject with dirty needles, and because street heroin can contain dangerous impurities.) So it is hard to say whether heroin is more dangerous than cigarettes or vice versa. Likewise while alcohol is more dangerous than marijuana in some respects, marijuana is more harmful in others, as shown below.

Furthermore, either-or comparisons can be moot, since the frequent users who dominate consumption and harm tend to be poly-substance users. Terry-McElrath et al. (2013) find that 62% of high school seniors who used marijuana within the past year reported simultaneous use of marijuana and alcohol. Likewise, household survey data suggest that the majority of daily and near-daily marijuana users consumed marijuana alongside alcohol the last time they used alcohol. If such an individual then drove, caused a crash, and failed a breathalyzer test for alcohol, that leaves open the question of how to apportion crash causality between alcohol-impairment and marijuana-impairment.

Total harm also depends on the frequency of an activity not just the harmfulness-per-event (MacCoun, 1998). Although alcohol intoxication may be associated with a greater increase in the risk of an auto crash per hour driven, Section 4.3 below shows that marijuana users report driving within two hours of use much more frequently than do alcohol users.

[6] The risks may be greater with the canisters from electronic cigarettes, c.f., Chatham-Stephens et al. (2014).

The goal here is not to argue that marijuana is more dangerous than alcohol. Rather, the goal is simply to rebut the facile assumption that marijuana is safer by looking at users' own statements concerning problems caused by the two substances.

1.3 Preview of Methods and Limitations

The U.S. household surveys offer many advantages for studying drug-related consequences. They are large, nationally-representative, and well-run.[7] Data are readily available back to 1979, including every year starting in 1990.[8]

Surveys also have drawbacks. For one, the data stem from self-report. Denial is a hallmark of addiction and even non-addicted users obfuscate, so rates of both marijuana- and alcohol-related harms may be under-reported.[9]

Survey responses are also sensitive to idiosyncrasies of question wording. Indeed, there are instances in which a seemingly modest change between the way questions were asked in 1998 and 1999 appears to have led to substantially lower reporting of problems.

One defense against these concerns is to focus on relative rates of reporting problems on questions that are asked in parallel about alcohol and about marijuana. For example, the 2012 National Survey on Drug Use and Health (NSDUH) asked:

"During the past 12 months, did you have any problems with family or friends that were probably caused by your drinking?"

and, similarly,

"During the past 12 months, did you have any problems with family or friends that were probably caused by your use of marijuana or hashish?"

with results coded as variables ALCFMFPB and MRJFMFPB, respectively.

Factoring in the survey sampling weights, the responses translate to an estimated 7,453,000 people in the country saying "yes" to the alcohol question. Since 135,365,000 people reported

[7] That the survey is nationally representative distinguishes this work from that of Morgan et al. (2010, 2013) or Carhart-Harris (2013) who found, not surprisingly, that when one asks samples recruited at least in part from drug-oriented web sites, they report many benefits and not so many harms from illegal drugs.

[8] Analyses here were done with data downloaded from the Substance Abuse and Mental Health Data Archive (SAMHDA), http://www.icpsr.umich.edu/icpsrweb/SAMHDA/sda.

[9] For example, in 2011 the Drug Abuse Warning Network (DAWN) records 183,000 emergency department episode in which marijuana was mentioned, and in 129,000 of those episodes marijuana was the only drug mentioned. By comparison, the 2011 NSDUH estimated that 527,000 in the household population report suffering physical problems caused by their marijuana or hashish use.[9] (Variable MRJPHCTD asks "During the past 12 months, did you have any physical health problems that were probably caused or made worse by your use of marijuana or hashish?") While it is possible that between 129,000 / 527,000 = 24% and 183,000 / 527,000 = 35% of marijuana-induced physical problems were serious enough to require a trip to the emergency department, it also seems possible that physical problems were underreported in the household survey, which would tend to inflate those proportions.

using alcohol within the last 30 days, this implies a self-reported problem rate of 0.055 per current alcohol user. (Use within the last 30 days is a common metric for "current" use.)

The corresponding numbers for marijuana are smaller because fewer people use marijuana. An estimated 1,593,000 people reported experiencing marijuana-related problems with family or friends, as against 19,070,000 past-month users, for a problem rate of 0.084 per current marijuana user.

That means that marijuana users reported problems at a rate that was 1.5 times greater than did alcohol users, since 0.084 / 0.055 = 1.5. The main outcome metric in this report will be ratios of this sort.

Relative rates are not immune to under-reporting. If there were something about alcohol that made its users reluctant to report problems with friends or family and/or something about marijuana that led its users to exaggerate how often its use caused such problems then that would artificially inflate the risk ratio. Likewise, if marijuana users understood the question differently, either because of the peculiar effects of marijuana intoxication or simply because marijuana users tend to be younger and less educated than alcohol users, then even though the two survey questions are parallel, their interpretation by respondents might not be. However, such conjectures are a bit strained, and they do not obviously bias the results in favor of either drug. On the whole, examining relative rates is perhaps as close to an even-handed comparison as one could ever make with national-level data.

Four more significant limitations should be noted, however.

First, all problems are self-diagnosed, not clinically assessed, and they reflect simple counts of people experiencing a problem, not the severity of those problems.

Second, for obvious reasons survey data ignore the outcome of premature death. Although marijuana use does occasionally lead to death,[10] that is extraordinarily rare, whereas it is distressingly common for alcohol.

Third, the survey questions provide next to no information about harms imposed on others. They do not ask, for example, "Did your use of this drug cause you to assault, rape, or kill another person?" Omitting such questions is understandable; rates of voluntary reporting would presumably be extremely low. But it is well-known that alcohol causes a great deal of crime, and marijuana does not; the bulk of drug-related crime pertains to cocaine/crack, heroin, and methamphetamine (Pacula et al., 2013).

Fourth, the ratios do not measure causality, only users' perceptions of causality. (Section 3 discusses the proper interpretation of these ratios.)

However, the goal is not to provide a complete or definitive statement about the overall riskiness of these two substances', but rather to supplement other, familiar sources by drawing on the complementary strengths of these data. This analysis in no way renders moot interest in, say,

[10] Healy (2014) describes two deaths connected to marijuana sold in Colorado stores.

National Highway Traffic Safety Administration data on proportions of drivers in fatal accidents who had one drug or the other in their system. It is worth noting that the survey questions analyzed here lean toward what might be termed social and behavioral outcomes, in contrast with the greater emphasis placed on health outcomes by Volkow et al. (2014), among others, although the spheres overlap.

The rest of this report is organized as follows. The next section presents results from the 2012 NSDUH and notes that the results are similar for every survey from 2000 - 2012. The following section assesses strengths and weaknesses of the ratios as measures of riskiness, and discusses their interpretation. Section 4 computes similar risk ratios using data from (almost) all the surveys from 1988 to the present. The questions vary over time, but were more or less stable for three periods: 1988 – 1993, 1994 – 1999, and 2000 - 2012. The main purpose is not to show changes from one year to the next, but rather to show that the findings from 2012 are not somehow aberrant, and to observe that risk ratios greater than 1.0 (meaning marijuana use is riskier) are the norm across a wide range of questions. Section 4 also looks in detail at a module on impaired driving that was only asked in the 1996 NHSDA. Appendix B reports on marijuana-related problems reported in the 1979 survey, although parallel questions were not asked concerning alcohol.

2.0 Results from the Most Recent Surveys

2.1 Rates of Problems Reported in the 2012 Survey

The 2000 – 2012 household surveys asked a series of questions about problems that respondents believed they experienced because of their substance use. Table 1 summarizes marijuana users' rate of reporting marijuana-related harms compared with the corresponding rates for alcohol users, using the 2012 survey. The denominator is the number of "current" users, defined as the number who report use in the last 30 days.[11] (Section 3 discusses alternative denominators.)

The table is somewhat overwhelming, so it is worth walking through the calculations step-by-step for the first variable. Alcohol users were asked:

> "During the past 12 months, was there a month or more when you spent a lot of your time getting or drinking alcohol?"

Marijuana users were asked a parallel question substituting the words "getting or using marijuana or hashish" for "getting or drinking alcohol". Of the 19 million past-month marijuana users, 9.7 million (51%) said yes. Likewise, there were 135.4 million past-month alcohol user and 21.2 million (16% as many) who said yes to the alcohol question. So marijuana users generated 3.2 times as many problem reports as did alcohol users (51% / 16% = 3.2) with regard to this particular issue.[12]

The 2000 – 2012 surveys asked 18 such questions of both marijuana and alcohol users, although the comparison is a little more complicated for two pairs of questions. With respect to setting limits on consumption and trying to cut down, respondents were asked both if they had tried and also if they had succeeded. High rates of success at limiting or cutting down use are a good not a bad thing, so the table has rows for the proportion of all users who tried minus the proportion who succeeded (meaning, the proportion who failed) and also for the proportion who failed just among those who tried. Again, a numerical illustration may help.

Among the 19M marijuana users, 7.7M (41%) said that within the last 12 months they had tried to set limits on their consumption, and 6.2M said that they had been able to abide by those limits. Table 1 includes the 41%, the corresponding proportion for alcohol (36%) and the ratio of those proportions (1.1). However, setting limits is not necessarily a bad thing. The problem would be failing to live within self-set limits, so Table 1 also includes a row for the 7.7M – 6.2M = 1.5M marijuana users who tried but failed, their proportion among all past-month users (8%) and how much higher that proportion is (1.7 times) than is the proportion (5%) for alcohol. Finally, Table 1 also observes that 19% of marijuana users who tried to set limits failed in that endeavor (1.5M / 7.7M = 19%), and that proportion is 1.5 times greater than the corresponding 13% for alcohol.

The relative rates column is highlighted in boldface in Table 1. Values greater than 1.0 suggest that past-month marijuana use is associated with greater rates of problems than is past-month alcohol use, whereas values less than 1.0 suggest that marijuana is less harmful.

[11] The tobacco literature often focuses on past-month users who have consumed on at least 100 occasions in their life. Unfortunately, the question about number of times ever used (MJTOT) was dropped after the 1998 survey.
[12] Marijuana legalization might reduce time spent getting marijuana.

Table 1: Risk Ratios of Marijuana vs. Alcohol Use per Past-Month User
As Reported in the 2012 National Survey on Drug Use and Health

	Marijuana		Alcohol			
Question wording (for alcohol; MJ question wording is parallel)	Number of Respondents Answering Yes	Number Answering Yes per PM User	Number of Respondents Answering Yes	Number Answering Yes per PM User	Relative Rate	Name of NSDUH Alcohol Variable
During the past 12 months, was there a month or more when you spent a lot of your time getting or drinking alcohol?	9,672,702	0.51	21,269,405	0.16	**3.2**	ALCLOTTM
During the past 12 months, was there a month or more when you spent a lot of time getting over the effects of the alcohol you drank?	262,226	0.01	2,258,533	0.02	**0.8**	ALCGTOVR
During the past 12 months, did you try to set limits on how often or how much alcohol you would drink?	7,736,321	0.41	48,234,790	0.36	**1.1**	ALCLIMIT
Were you able to keep to the limits you set, or did you often drink more than you intended to?	6,242,021		41,934,784			ALCKPLMT
Tried to set a limit but failed to keep it. (Difference of two above)	1,494,300	0.08	6,300,006	0.05	**1.7**	
Proportion of those setting limits who failed to keep them	19%		13%		**1.5**	
During the past 12 months, did you need to drink more alcohol than you used to in order to get the effect you wanted?	4,747,506	0.25	10,297,881	0.08	**3.3**	ALCNDMOR
During the past 12 months, did you notice that drinking the same amount of alcohol had less effect on you than it used to?	1,939,851	0.10	11,349,174	0.08	**1.2**	ALCLSEFX
During the past 12 months, did you want to or try to cut down or stop drinking alcohol?	8,875,441	0.47	38,379,161	0.28	**1.6**	ALCCUTDN
During the past 12 months, were you able to cut down or stop drinking alcohol every time you wanted to or tried to?	7,515,185		32,277,980			ALCCUTEV
Tried to cut down but failed to do so. (Difference of two above)	1,360,256	0.07	6,101,181	0.05	**1.6**	
Proportion who set limits but failed to keep them.	15%		16%		**1.0**	
During the past 12 months, did you have any problems with your emotions, nerves, or mental health that were probably caused or made worse by drinking alcohol?	2,112,229	0.11	9,751,410	0.07	**1.5**	ALCEMOPB
Did you continue to drink alcohol even though you thought drinking was causing you to have problems with your emotions, nerves, or mental health?	1,334,794	0.07	5,955,484	0.04	**1.6**	ALCEMCTD
During the past 12 months, did you have any physical health problems that were probably caused or made worse by drinking alcohol?	492,660	0.03	3,821,385	0.03	**0.9**	ALCPHLPB
Did you continue to drink alcohol even though you thought drinking was causing you to have physical problems?	249,193	0.01	1,761,736	0.01	**1.0**	ALCPHCTD
This question is about important activities such as working, going to school, taking care of children, doing fun things such as hobbies and sports, and spending time with friends and family. During the past 12 months, did drinking alcohol cause you to give up or spend less time doing these types of important activities?	2,256,927	0.12	6,175,555	0.05	**2.6**	ALCLSACT
Sometimes people who drink alcohol have serious problems at home, work or school - such as: Neglecting their children, Missing work or school, Doing a poor job at work or school, Losing a job or dropping out of school. During the past 12 months, did drinking alcohol cause you to have serious problems like this either at home, work, or school?	1,493,348	0.08	3,853,539	0.03	**2.8**	ALCSERPB
During the past 12 months, did you regularly drink alcohol and then do something where being drunk might have put you in physical danger?	1,277,983	0.07	10,841,087	0.08	**0.8**	ALCPDANG
During the past 12 months, did drinking alcohol cause you to do things that repeatedly got you in trouble with the law?	549,272	0.03	2,075,350	0.02	**1.9**	ALCLAWTR
During the past 12 months, did you have any problems with family or friends that were probably caused by your drinking?	1,592,896	0.08	7,452,518	0.06	**1.5**	ALCFMFPB
Did you continue to drink alcohol even though you thought your drinking caused problems with family or friends?	1,219,025	0.06	5,089,923	0.04	**1.7**	ALCFMCTD

Question wording and variable name are given only for alcohol to save space. Questions are parallel for marijuana and the marijuana variable names are the same as the alcohol variable names, just with "ALC" replaced by "MRJ".

The overall gist of the relative rate column is that most of the ratios are greater than 1.0, and none is much less than 1.0. One can be more specific by defining three categories of ratios:

- "***No appreciable difference***" – if the ratio is less than 1.25 in both directions. (I.e., marijuana is no more than 1.25 times worse than alcohol and alcohol is no more than 1.25 worse than marijuana.)
- "***Modestly greater risk***" – for ratios between 1.25 and 2.0 or 2.5. (The exact upper cut-off does not matter since none of the ratios were between 2.0 and 2.5.)
- "***Significantly higher risk***" – for ratios above 2.0 or 2.5

Marijuana appears to be significantly more risky with respect to both measures pertaining to ability to fulfill life roles (creates serious problems at home, work, or school and use causes one to spend less time on important life activities).

Marijuana appears to be modestly riskier with respect to the four questions pertaining to social relationships and mental health, and also with respect to problems with self-control. In particular, marijuana users report greater rates of trying but failing to abide by limits they set (ratio 1.6) and trying but failing to cut down on use (ratio 1.5).[13]

Marijuana also appears modestly riskier with respect to legal problems, but that is presumably a function of marijuana's illegality, not anything intrinsic to the drug, and so should not be held against marijuana when contemplating changes in marijuana's legal status.

Neither drug is cited at greater rates than the other with respect to physical symptoms or use before doing something physically dangerous. Indeed, alcohol is slightly worse on those measures. This accords with evidence presented by those arguing that marijuana is safer than alcohol; e.g., Ingraham (2013) notes that alcohol generates one-third more emergency department mentions per 1,000 past-month users (35.2 vs. 26.5). If acute, physical harms were the only harms, marijuana would perhaps be cited only about three-quarters as often as alcohol.

The pairs of questions pertaining to time and to tolerance gave inconsistent results. Marijuana users were much more likely to report spending a lot of time obtaining and using their drug (ratio 3.3) but not on getting over the effects of using (ratio 0.8). Marijuana users were much more likely to report needing more to get the same effect (ratio 3.3) but not feeling less effect when using the same amount (ratio 1.2). (It is not clear why the ratios for the last two questions should differ so much.)

Overall, the data suggest that marijuana is significantly more likely to interfere with life functioning. It is moderately more likely to create challenges of self-control and to be associated with social and mental health problems. The other differences are either small or inconsistent.

[13] The particulars of the two pairs of self-control questions differ. Marijuana users were no more likely than alcohol users to try to limit their use, but had a higher failure rate when they did so; conversely, they were more likely to try to cut down but conditional on an attempt, failed at rates similar to alcohol users. In both cases, though, larger proportions of users tried but failed to constrain their use.

Table 2: Degree to Which Marijuana Users Were More Likely than Alcohol Users to Report Problems

Significantly more likely	Life functioning
Moderately more likely	Self-control, social relationships, and mental health Legal problems*
No appreciable difference	Physical problems and danger
Inconsistent (one indicator significantly more likely & one no more likely)	Tolerance and time lost to drug

*Legal problems are likely attributable to marijuana's legal status, not its psychopharmacological effects per se.

2.2 Stability of Rates from 2000 to 2012

The statements above are based on just one survey year (2012). Table 3A replicates the analysis for all thirteen surveys that included these questions (survey years 2000 to 2012).

Table 3A: Risk Ratios by Year, 2000 - 2012

Question (abbreviated)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Spent a lot of time using	3.6	3.9	3.3	3.2	3.1	3.2	3.2	3.1	3.2	3.1	3.3	3.4	3.2
Spent a lot of time getting drug	1.3	1.0	0.8	1.2	0.9	1.1	1.2	0.7	0.7	1.1	1.2	0.8	0.8
Tried to set limits on use?	1.3	1.3	1.3	1.3	1.3	1.2	1.3	1.2	1.2	1.2	1.2	1.2	1.1
Able to abide by those limits													
Failed to abide by limit. (Difference of two above)	2.6	2.6	2.0	2.3	1.8	2.0	2.0	2.0	1.8	1.9	1.9	1.9	1.7
Proportion of those setting limits who failed	2.0	2.0	1.6	1.7	1.3	1.6	1.5	1.6	1.5	1.5	1.6	1.6	1.5
Need more of drug to get effect desired?	3.1	3.5	3.1	3.1	3.0	3.2	3.3	2.9	3.2	3.0	3.0	3.3	3.3
Same amount of drug had less effect?	1.2	1.2	1.0	1.2	1.0	1.0	1.1	1.1	1.0	1.0	1.2	1.4	1.2
Tried to cut down or stop?	2.0	1.9	1.8	1.8	1.9	1.8	1.8	1.7	1.8	1.7	1.7	1.7	1.6
Able to cut down or stop?													
Failed attempt to cut down/stop (Difference of two above)	2.3	1.9	2.1	2.0	1.8	1.9	2.0	1.8	1.8	1.7	1.7	1.5	1.6
Proportion of those cutting down who failed	1.2	1.0	1.2	1.1	1.0	1.0	1.1	1.0	1.0	1.0	1.0	0.9	1.0
Mental health problems caused/made worse?	2.6	2.4	2.0	1.8	2.0	2.0	2.0	1.8	1.9	1.9	1.8	1.7	1.5
Continued use despite mental health problems?	3.1	2.7	2.2	1.9	2.3	2.1	2.2	1.9	2.3	2.0	2.0	1.7	1.6
Physical health problems caused/made worse?	1.7	1.7	1.2	1.5	1.4	1.5	1.3	1.5	1.1	1.2	1.0	1.2	0.9
Continued use despite physical health problems?	2.7	2.0	1.4	1.9	1.8	2.3	1.7	2.0	1.5	1.6	1.1	1.5	1.0
Caused user to spend less time on important activities?	3.2	3.7	2.8	2.7	2.9	3.0	3.0	2.9	2.9	2.9	2.9	2.8	2.6
Use caused serious problems at home, work, or school?	3.7	3.5	2.9	2.8	2.9	3.0	2.7	2.9	2.8	2.8	2.7	2.5	2.8
Use before activities that created physical danger?	1.3	1.3	1.1	1.1	1.1	1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.8
Use caused trouble with the law?	2.8	3.2	2.5	2.2	2.7	2.6	2.6	2.3	2.4	1.9	2.1	2.5	1.9
Use caused problems with family or friends?	2.2	2.3	1.9	1.6	2.0	1.7	1.6	1.4	1.7	1.6	1.8	1.6	1.5
Continued use despite problems with family/friends?	2.6	2.6	2.1	1.8	2.3	1.9	1.8	1.4	1.7	1.8	2.1	1.9	1.7

Table 3A is may be hard to digest so Table 3B contrasts the risk ratios from 2012 with the average of the three most recent surveys (2010-2012) and the last eleven (2002-2012).[14] The results do not change much when considering more years of data. Indeed, if anything the ratios were higher in the past, so focusing on the most recent year may be conservative in the sense of understating the extent to which marijuana can be riskier than alcohol.

[14] Results are similar averaging all 13 surveys or just the most recent 11. We show the average over just the 11 because the overall survey methodology was different in 2000 and 2001 (NHSDA vs. NSDUH) even though these particular questions did not change. In particular, the lower rates of self-reported marijuana use under the earlier survey format may have inflated the relative rate ratios in those two surveys.

Table 3B: Insensitivity of the Relative Ratios to the Time Period Considered

		Relative Rate	
Question wording (for alcohol; MJ question wording is parallel)	In 2012	3-Yr Average 2010-2012	11-Yr Average 2002-2012
During the past 12 months, was there a month or more when you spent a lot of your time getting or drinking alcohol?	3.2	3.2	3.2
During the past 12 months, was there a month or more when you spent a lot of time getting over the effects of the alcohol you drank?	0.8	1.0	0.9
During the past 12 months, did you try to set limits on how often or how much alcohol you would drink?	1.1	1.2	1.2
Were you able to keep to the limits you set, or did you often drink more than you intended to?			
Tried to set a limit but failed to keep it. (Difference of two above)	1.7	1.8	1.9
Proportion of those setting limits who failed to keep them	1.5	1.6	1.6
During the past 12 months, did you need to drink more alcohol than you used to in order to get the effect you wanted?	3.3	3.1	3.1
During the past 12 months, did you notice that drinking the same amount of alcohol had less effect on you than it used to?	1.2	1.2	1.1
During the past 12 months, did you want to or try to cut down or stop drinking alcohol?	1.6	1.7	1.8
During the past 12 months, were you able to cut down or stop drinking alcohol every time you wanted to or tried to?			
Tried to cut down but failed to do so. (Difference of two above)	1.6	1.6	1.8
Proportion who set limits but failed to keep them.	1.0	0.9	1.0
During the past 12 months, did you have any problems with your emotions, nerves, or mental health that were probably caused or made worse by drinking alcohol?	**1.5**	**1.7**	**1.8**
Did you continue to drink alcohol even though you thought drinking was causing you to have problems with your emotions, nerves, or mental health?	**1.6**	**1.8**	**2.0**
During the past 12 months, did you have any physical health problems that were probably caused or made worse by drinking alcohol?	**0.9**	**1.1**	**1.2**
Did you continue to drink alcohol even though you thought drinking was causing you to have physical problems?	**1.0**	**1.3**	**1.6**
This question is about important activities such as working, going to school, taking care of children, doing fun things such as hobbies and sports, and spending time with friends and family. During the past 12 months, did drinking alcohol cause you to give up or spend less time doing these types of important activities?	2.6	2.8	2.8
Sometimes people who drink alcohol have serious problems at home, work or school - such as: Neglecting their children, Missing work or school, Doing a poor job at work or school, Losing a job or dropping out of school. During the past 12 months, did drinking alcohol cause you to have serious problems like this either at home, work, or school?	2.8	2.7	2.8
During the past 12 months, did you regularly drink alcohol and then do something where being drunk might have put you in physical danger?	0.8	0.9	1.0
During the past 12 months, did drinking alcohol cause you to do things that repeatedly got you in trouble with the law?	**1.9**	**2.1**	**2.3**
During the past 12 months, did you have any problems with family or friends that were probably caused by your drinking?	1.5	1.6	1.7
Did you continue to drink alcohol even though you thought your drinking caused problems with family or friends?	1.7	1.9	1.9

The five ratios that changed the most are marked in bold. It is not surprising to see a decline over time in the ratio for the questions asking whether use caused one to do things that repeatedly created trouble with the law; that is consistent with marijuana policy moving toward decriminalization and legalization for medical use. There were also reductions in the ratios for problems pertaining to physical and mental health.

2.3 Rates of Abuse and Dependence

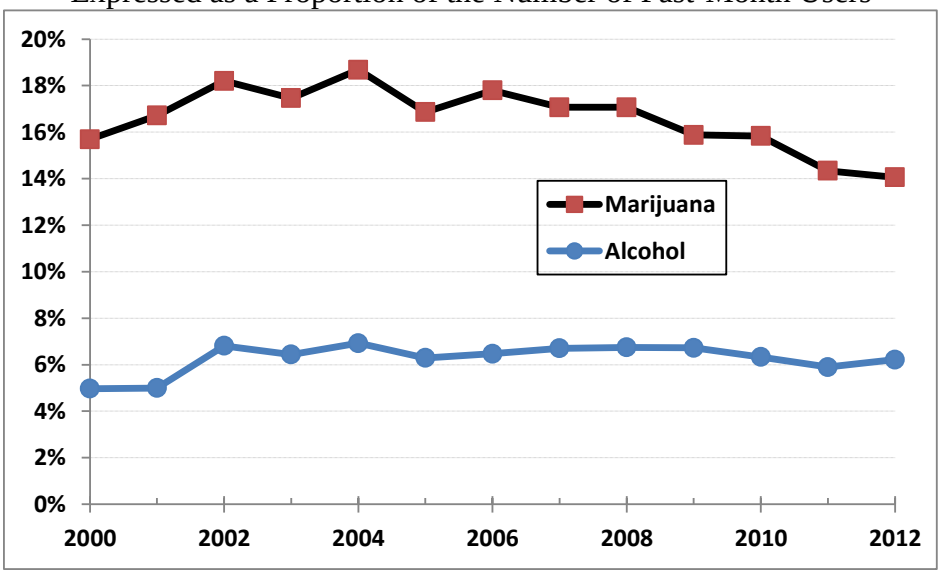
NSDUH asks about problems to inform its estimates of numbers of people who meet the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV) criteria for substance abuse and dependence. NSDUH codes respondents as marijuana dependent if they report at least three of the following six problems:[15]

1. Spent a great deal of time over a period of a month getting, using, or getting over the effects of the substance (XXXLOTTM=1 or XXXGTOVR=1)
2. Unable to keep set limits on substance use or used more often than intended (XXXKPLMT=2)
3. Needed to use substance more than before to get desired effects or noticed that using the same amount had less effect than before (XXXNDMOR=1 or XXXLSEFX=1)
4. Unable to cut down or stop using the substance every time he or she tried or wanted to (XXXCUTEV=2)
5. Continued to use substance even though it was causing problems with emotions, nerves, mental health, or physical problems (XXXEMCTD=1 or XXXPHCTD=1)
6. Reduced or gave up participation in important activities due to substance use (XXXLSACT=1

Alcohol dependence was assessed if the respondent reported at least three of seven concerns, these six plus also withdrawal. So it is easier to be assessed as alcohol dependent because there is a seventh contributor to the number of problems reaching the threshold of three problems.

Nevertheless, in every year from 2000 – 2012 the number of respondents judged to meet DSM-IV dependence criteria per past-month marijuana user was 2.3 – 3.3 times higher than was the corresponding rate for past-month alcohol users.

Figure 1: Number of People Meeting DSM-IV Criteria for Marijuana and Alcohol Dependence, Expressed as a Proportion of the Number of Past-Month Users



[15] Text quoted from the online codebook available at http://www.icpsr.umich.edu/SDA/SAMHDA/34933-0001/CODEBOOK/2012.htm. Dependence recorded in variable DEPNDMRJ.

Abuse for marijuana and for alcohol is assessed if the respondent did not meet the criteria for dependence but did give a positive response to one or more of the following four criteria (again quoting from the codebook):

1. Respondent reported having serious problems due to substance use at home, work or school (XXXSERPB=1)
2. Respondent reported using substance regularly and then did something where substance use might have put them in physical danger (XXXPDANG=1)
3. Respondent reported substance use causing actions that repeatedly got them in trouble with the law (XXXLAWTR=1)
4. Respondent reported having problems caused by substance use with family or friends (XXXFMFPB=1) and continued to use substance even though it was thought to be causing problems with family and friends (XXXFMCTD=1)

The number of respondents judged to meet DSM-IV criteria for abuse, as a proportion of the number of past-month users, was 1.2 – 1.6 times higher for marijuana than for alcohol. For the combined diagnoses of abuse or dependence, that ratio was 1.7 – 2.2 times higher for marijuana, depending on the year.

The variables coding trouble with the law (XXXLAWTR) enter the assessment of abuse (but not dependence), and some of those problems for marijuana are caused by prohibition, not by the drug per se. However, adjusting the abuse variable for both marijuana and alcohol to exclude the XXXLAWTR variables has little effect. With the 2012 survey, it reduces the numbers who meet the criteria for abuse by only 7% and 4% for marijuana and alcohol, respectively. Since the XXXLAWTR variables have no bearing on the numbers estimated to meet the criteria for dependence, the reductions in the numbers meeting the criteria for either abuse or dependence are even smaller (3% and 2%, respectively).

3.0 Issues of Methodology and Interpretation

3.1 Definition of the ratios

The ratios of problem rates in this report are aggregate ratios based on historical use patterns that actually occurred in the country. They are not individual risk ratios that infer causal associations by controlling for covariates. There are pros and cons of both types of ratios. Only the aggregate, descriptive ratios can be computed from household survey data, so that is what is presented here, and it is important to understand the differences in order to interpret the ratios presented here correctly.

The aggregate ratios are simply descriptions of what "actually" happened in the country in aggregate – with "actually" in quotes because of the inevitable limits of self-report, imperfect survey coverage etc. that also affect survey-based estimates of individual level ratios. The aggregate ratios are akin to societal-level cost-benefit ratios or harm indices (Ritter, 2009), except that they are computed for one adverse outcome at a time, rather than monetizing each bad outcome and aggregating across them.

In an equation the:

$$Rate\ for\ marijuana = \frac{\#\ of\ bad\ outcomes\ caused\ by\ MJ\ use}{\#\ of\ current\ MJ\ users}$$

and

$$Rate\ for\ alcohol = \frac{\#\ of\ bad\ outcomes\ caused\ by\ alcohol\ use}{\#\ of\ current\ alcohol\ users}$$

The relative rate ratio for one type of outcome is just

$$Relative\ rate = \frac{\frac{\#\ of\ bad\ outcomes\ caused\ by\ MJ\ use}{\#\ of\ MJ\ users\ in\ the\ country}}{\frac{\#\ of\ bad\ outcomes\ caused\ by\ alcohol\ use}{\#\ of\ alcohol\ users\ in\ the\ country}}$$

If one thought that past-month marijuana use and past-month alcohol use each brought the same amount of pleasure (happiness, utility), then these ratios indicate how much greater a cost society has been paying per unit of benefit derived from marijuana use relative to alcohol use.

Use of the past tense ("has been") is intentional; these rates are averages based on historical patterns of use. If a policy change brought new people into the user pool, their problem rates could be different. In the jargon of policy analysis, the average rates reported here could be different than those of the marginal users in the future. Likewise, the ratios could suffer from a selection effect if the current policy environment skews the types of people who use the substances. For example, if only people who are particularly vulnerable to having problems choose to use marijuana when it is prohibited, the ratios after legalization might be more favorable toward marijuana than they have been in the past.

3.2 Causal inference

One commonly sees risk ratios computed at the individual-level while controlling for various covariates when attempting to ascertain causality in non-experimental data. For example, suppose one wanted to determine whether using marijuana causes lung cancer. The simple ratio of lung cancers per marijuana user divided by lung cancers per non-user would not be a good indicator of the extent to which marijuana causes lung cancer because marijuana users are much more likely than non-users to smoke tobacco. So epidemiologists would control for tobacco use. In a sense, they would look at the ratio just among tobacco smokers and the same ratio computed just among those who have not used tobacco. In practice, they do not literally compute separate ratios for each subset of the population, but multivariate regression accomplishes a similar purpose.

Here, the goal is not to tease out causality from secondary data. The surveys ask respondents directly if their use caused them a problem, and we take users' at their word.

So it might be more precise to speak not of the number of problems caused by marijuana or alcohol, but rather the number of Self-Identified Substance-Use Problems – SISUP – but rather than constantly repeating that awkward phrase, the qualifier is left implicit. As discussed already, one might expect users to understate the extent to which either substance is causing problems, but if the understatement is proportional, that would not affect the relative rates.

The second component of the contrast pertains to whether one controls for differences in the composition of the two substances' user base. This point is perhaps best made with a numerical example. Suppose that both Drug A and Drug B cause an adverse outcome that is much more common among women than men (e.g., breast cancer), Drug B does so at double the rate per user regardless of gender, and for whatever reason women shun Drug B, so three-quarters of those who use Drug A are women, vs. only about 18% for Drug B.

Table 4 illustrates the calculations that would be done here to conclude that Drug A causes twice as many adverse outcomes per user as does Drug B.

Table 4: Hypothetical Example to Illustrate Risk Ratios Computed Here

Data	**Drug A**	**Drug B**
# of outcomes females attribute to drug use	37,500	17,993
# of outcomes males attribute to drug use	125	820
# of female users	750,000	179,925
# of male users	250,000	820,075
# of outcomes users attribute to drug use	37,625	18,813
# of users	1,000,000	1,000,000
# of outcomes per user	0.037625	0.018813
Relative rate of problems reported per user	**2.000**	

Table 5 sketches a stylized version of the calculations that would be done in a typical epidemiological study to conclude that for any individual, regardless of gender, starting to use Drug B is twice as risky as is starting to use Drug A, with respect to this outcome.

Table 5: Simplified Epidemiological Calculations for This Hypothetical Example

Data	**No Drug**	**Drug A**	**Drug B**	
# of outcomes among females	20,000	67,500	25,190	
# of outcomes among males	200	225	1,148	
# of female users	500,000	750,000	179,925	
# of male users	500,000	250,000	820,075	
(Simplified) Epidemiological Calcs.				
# of outcomes per 100 females who do not use	4			
# of outcomes per 100 males who do not use	0.04			
# of outcomes expected among females (if no drug were used)		30,000	7,197	
# of outcomes expected among males (if no drug were used)		100	328	
# of excess outcomes among females (assumed due to drug)		37,500	17,993	
# of excess outcomes among males (assumed due to drug)		125	820	**RR Ratio**
excess outcome rate per 100 females		0.05	0.1	**0.5**
excess outcome rate per 100 males		0.0005	0.001	**0.5**

The epidemiological analysis is more complicated because it has to infer which adverse outcomes are attributed to the drug by comparing outcomes of those who used with a no-use control group. However, the eight highlighted cells in the two tables all have identical numbers, illustrating that both tables are considering the exact same situation. And both calculations are correct. For one individual contemplating drug use, Drug B is twice as risky; for society as a whole, Drug A generates twice as much harm per unit of use (and in this example also in total since both drugs are used by the same number of people).

So if policy makers could cut the use of either substance by 50% (at the same cost and without creating substitution from one drug to the other) then applying that intervention to Drug A would prevent more adverse outcomes than would intervening with Drug B.

Both types of ratios are valuable, but with household survey data, calculating the societal-level average self-reported harm per unit of use is trivial where it is impossible to do the individual-level calculation properly. That would require controlling not only for gender and other fixed characteristics, but also for variables such as educational attainment whose values can in turn be caused by drug use. That reciprocal feedback or "endogeneity" cannot easily be sorted out in cross-sectional data. At a minimum disentangling reciprocal effects requires longitudinal data, and even longitudinal data may not suffice. For example, the oft-cited finding that prolonged intensive marijuana use by youth is associated with measurably lower IQ in adulthood came from a very careful longitudinal study (Meier et al., 2012), but that conclusion has nonetheless been dismissed (Daly 2013; Rogeberg 2013a, 2013b). It is not clear that the finding should be rejected (see, e.g., Moffitt et al., 2013; Jacobus et al., 2013), but it appears not to have changed many minds, and all agree it is very hard to infer causal effects reliably from observational (as

opposed to experimental) data without some exogenously driven changes in the independent variables.

Since household surveys offer limited possibilities along those lines, this report sidesteps the statistical inference problems by focusing on variables that pertain not just to the presence or absence of an adverse outcome, but rather to outcomes that the users themselves describe as having been caused by the substance.

3.3 Choice of denominator

The ratios reported here are a measure of the amount of harm per unit of use. More specifically, they are the number of people reporting that they were adversely affected by the drug per current user – meaning per person who reports use within the past-month. The number of current users is arguably the most natural and most informative denominator, but two other possibilities bear mention: the number of past-year users and the number of days of use.

Superficially one might prefer denominating by the number of past-year users, since the questions ask about problems within the last year. However, infrequent use (less than monthly) is unlikely to cause problems, and the ratio of light to heavy users can vary substantially over time (Everingham and Rydell, 1994; Caulkins et al., 2004). So denominating by the number of past-year users could introduce spurious fluctuations into the ratios.

Note: there are some people who report using only in the past year, and not within the past month, who nonetheless say the drug caused them problems within the last year. One might guess that many of them had been using with greater frequency earlier in the year, when the problem occurred, and have since quit or de-escalated their use. This does not amount to double counting since in steady state those who de-escalate are mirrored by others who have recently escalated to frequent use and who may not yet have had time to develop problems from that use.

The second alternative denominator would be days of use. Superficially this might appear to help capture intensity of use, not just prevalence. It would count two people who use half-as-intensively as equal to one "full-time" user, in the same manner that accountants might convert part-time workers into full-time equivalents (FTEs). Indeed, this approach might be preferable if the measure of use were denominated in grams not days of use, but the relationship between intensity of use and days of use plays out differently for different substances.

A pack-a-day smoker might smoke only half as intensively as a two-pack-a-day smoker, and might be exposed to only half the carcinogens, but most pack-a-day smokers still use daily. By contrast, those who are addicted to crack often use episodically, in binges. So someone who abuses crack half as intensively might participate in half as many binges and, so, use on half as many days in the past month. Neither marijuana nor alcohol may be as extreme on this spectrum as tobacco and crack, but they do differ and marijuana appears to be more like tobacco, in this regard, particularly of late.

Past-month marijuana users are now more than three times as likely to use daily or near-daily as are past-month drinkers (33.4% vs. 10.6%), where "daily & near-daily" is defined as reporting use on 21 or more days in the past month.

Figure 2: Proportions of Past-Month Marijuana and Alcohol Users by Number of Days Used in the Last Month; Marijuana Users are Three Times as Likely to Use Daily or Near-Daily

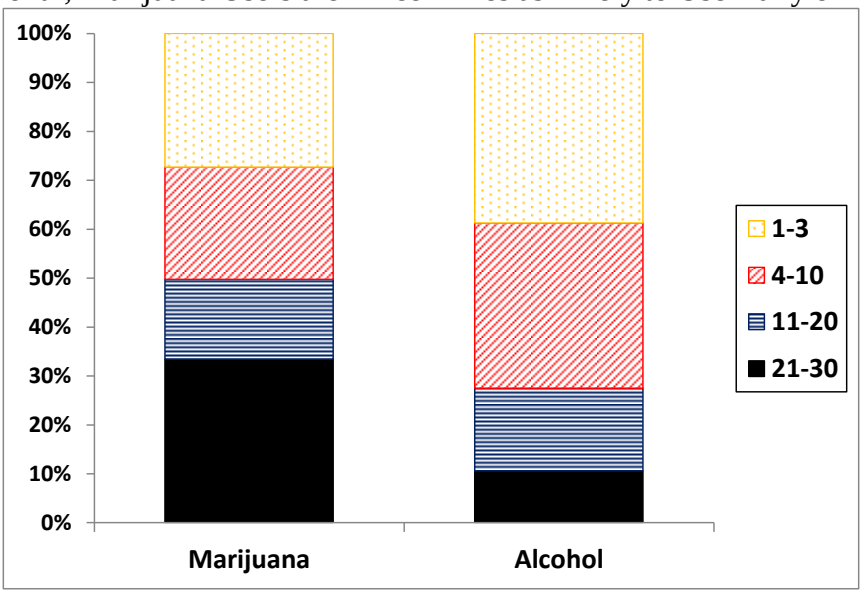
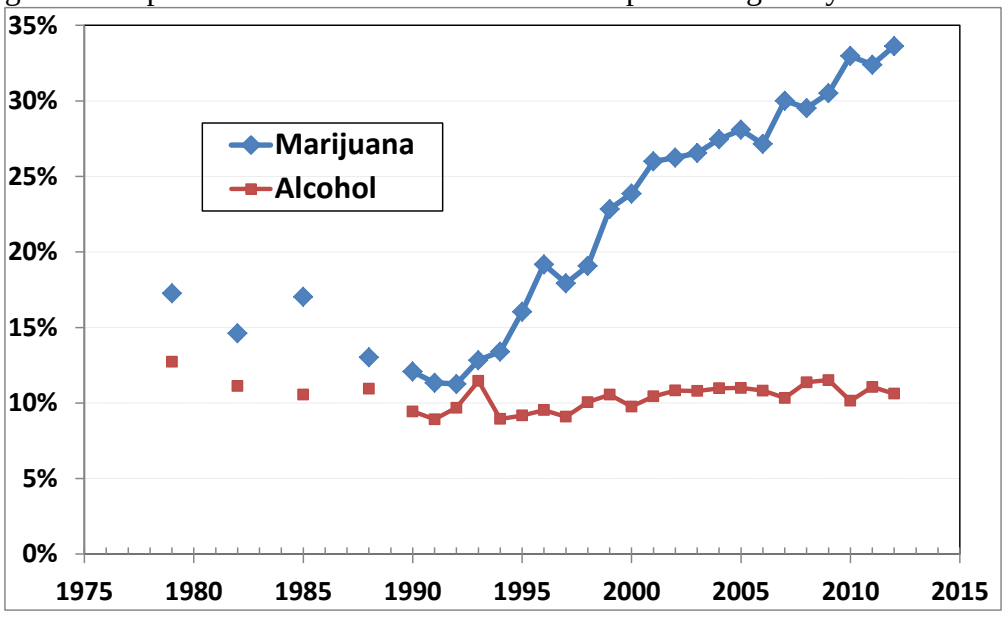


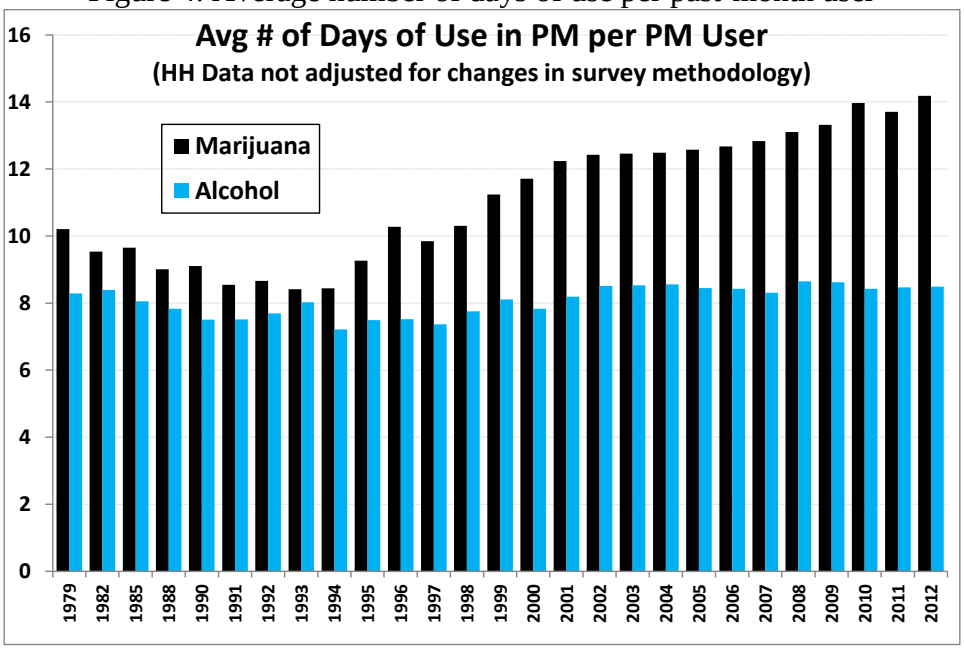
Figure 3 shows how this has changed over time. Before the mid-1990s, the proportion of past-month marijuana users who reported using daily or near-daily was only modestly greater than was the corresponding proportion for past-month alcohol users (~15% vs. ~10%), but the proportion for marijuana has grown to one-third while the alcohol proportion remained stable.

Figure 3: Proportion of Past-Month Users Who Report Using Daily or Near-Daily



There is a corresponding increase in the average number of days of use per past-month user. (See Figure 4)

Figure 4: Average number of days of use per past-month user



As a result, if the ratios are computed per day of use, not per month with use, then marijuana does not look as much more harmful than alcohol. Roughly speaking, the ratios would all be about one-third lower. So ratios that show significantly higher risk per person who uses in the 2012 data would show only modestly greater risk per day of use, and some that showed modestly greater risk per user fall into the "no appreciable difference" category. Indeed, for the physical problems and danger measures, alcohol shows a greater risk per day of use than does marijuana, even though their risks per current user were not appreciably different.

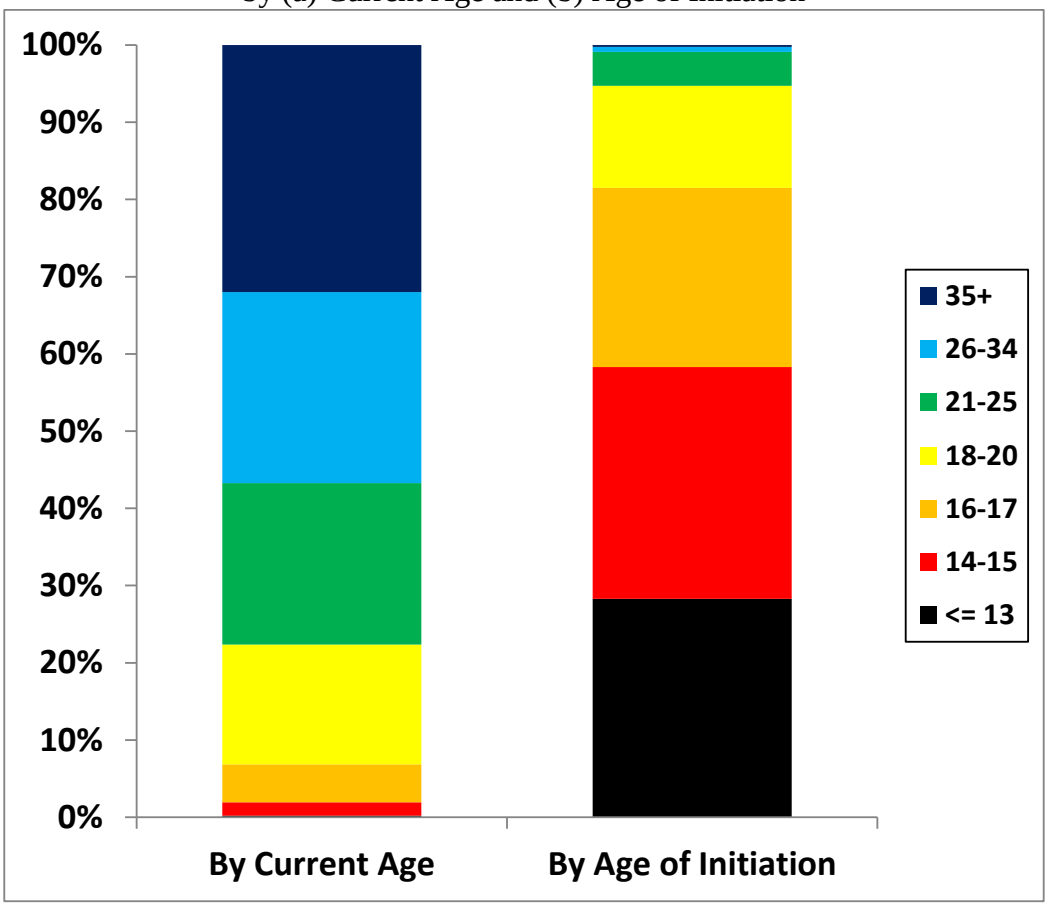
3.4 Do marijuana users willingly and knowingly accept these harms

Some people might acknowledge that marijuana causes harms, perhaps even greater harms on some dimensions than does alcohol, but still dismiss those harms as unimportant on the grounds that the benefits of using must exceed the harms, otherwise the users would not continue to use. A counter-argument to this libertarian logic is that dependence causes people to continue to use even when that use brings net harm. Believers in *homo economicus* reply that the risk of dependence can be anticipated and factored into the initial decision to use; since people continue to initiate, the benefits must exceed the costs, even factoring in dependence. To which, the standard reply is "Most initiation is by youth, and youth cannot be depended on to be so far-sighted, even assuming that adults are."

Household survey data cannot resolve this philosophical debate, but they do provide basic descriptive facts concerning amounts of initiation and use that are by those who are under 21 (which is the cut-off age in the two states that have legalized recreational use).

For self-reported days-of-use in the most recent (2012) NSDUH for which data have been released, people under the age of 21 accounted for just 22% of current use, but 95% of current use was by people who started using before the age of 21. (See Figure 5 below). The gap arises because almost everyone who initiates marijuana does so before they turn 21. Hence, almost all of the marijuana-related harms discussed in this report stem from use by people who initiated before they had fully matured in terms of cognitive development and social roles. Indeed, more than half of current marijuana use is by people who had already started using marijuana by age 15.

Figure 5: Distribution of Marijuana Use in the 2012 NSDUH
by (a) Current Age and (b) Age of Initiation



4.0 Problems with Drug Use Reported in Earlier Surveys

This section replicates the analysis in Section 2.0 for all household surveys that contained relevant questions that could be analyzed conveniently and delves into a special module on impaired driving that was included only in the 1996 survey.

Three notes on terminology are in order. First, the name of the survey changed from the National Household Survey on Drug Abuse (NHSDA) to the National Survey on Drug Use and Health (NSDUH) between 2001 and 2002, when the survey underwent a major redesign. SAMHSA discourages comparisons across that break point.

Second, two surveys were fielded in 1994. The main survey (1994B) pioneered new questions and methods. The smaller survey (1994A) replicated the 1993 survey to improve comparability over time. Data from the 1994A survey are not used; although it had the same raw questions as did the 1993 survey, it lacked the recoded summaries of those questions, which are used in analyzing the 1988 – 1993 surveys. Since few respondents were given the 1994A survey, this is not a major loss. Below references to the "1994 survey" should be understood to mean the "1994B" survey.

Third, SAMHDA provides downloadable datasets for three surveys not analyzed here. The 1979 survey included questions about perceived problems stemming from marijuana use, but parallel questions were not asked about alcohol, so these questions are not directly useful for present purposes. Nevertheless, they are interesting, in a quirky sort of way, and so are described in Appendix B.

The 1982 survey did not have any questions that bear on users' perceptions of use-related harms. The 1985 survey had the same questions as the 1988 – 1994A surveys, but like the 1994A survey lacked the recoded summary variables, so it is not analyzed.

4.1 Problems Reported in the 1988 – 1993 NHSDA Surveys

The 1985 – 1994A NHSDA surveys asked the following question about problems caused by drug use:

"If you have ever used cigarettes, alcohol, or any of the other substances listed on the card, please circle an answer for each question below. If you had any of these problems in the past 12 months from your use of any of the substances listed on the card, please circle the 01 for "yes" and write in the names of the substances you think probably caused the problem. If you did not have the problem in the past 12 months, circle the 02."

"As a result of drug use at any time in your life, did you, in the past 12 months:"

a. Become depressed or lose interest in things?
b. Have arguments and fights with family or friends?
c. Feel completely alone and isolated?
d. Feel very nervous and anxious?
e. Have health problems?
f. Find it difficult to think clearly?

```
g. Feel irritable and upset?
h. Get less work done than usual at school or on the job?
i. Feel suspicious and distrustful of people?
j. Find it harder to handle your problems?
k. Have to get emergency medical help?
l. Have someone suggest you seek treatment?
m. Drive unsafely?
```

For each of the 12 prompts, NHSDA includes variables recording up to five substances mentioned. E.g., for the first prompt, pertaining to depression, the variables are DEPDRG1A, DEPDRG2A, DEPDRG3A, DEPDRG4A, and DEPDRG5A. These variables provide a rich description including mention of many minor drugs. For example, in the 1993 NHSDA there were the equivalent of 5,867,265 people who wrote some variant of "alcohol" first in response to the prompt "Find it difficult to think clearly?" and another 1,163,674 who wrote marijuana first, but other drugs mentioned include cocaine (178,928), coffee (23,877), and hashish (8,041).

Alcohol and marijuana were also mentioned as the 2nd, 3rd, 4th, or 5th drug causing problems with thinking. In particular, 238,672 people mentioned alcohol under variables NTKDRG2A – NTKDRG5A, and 307,020 did so for marijuana.

The 1988 – 1993 NHSDAs aggregate across the five variables for each prompt to produce simple binary variables indicating whether or not a particular drug was mentioned at all in response to that prompt.[16] For convenience, the analysis uses those recoded variables, so for each year from 1998 – 1993[17] creates a table such as this one (for the 1993 survey).

Table 5: Relative Rates of Problems Mentioned per Past-Month Marijuana and Alcohol User in the 1993 NHSDA

Prompt	# Mentioning MJ	# Mentioning Alcohol	Marijuana mentions per PM MJ User	Alcohol mentions per PM Alcohol User	MJ vs. Alcohol Risk Ratio
Felt alone	205,267	2,674,279	0.02	0.03	0.9
Felt nervous	742,472	2,147,997	0.08	0.02	4.0
Had arguments/fights	479,596	5,974,879	0.05	0.06	0.9
Problems were hard to handle	245,117	2,035,194	0.03	0.02	1.4
Became depressed	500,511	3,589,272	0.06	0.03	1.6
Sought emergency medical help	24,308	568,628	0.00	0.01	0.5
Had health problems	163,729	1,199,772	0.02	0.01	1.6
Got less work done	639,478	2,684,978	0.07	0.03	2.7
Had difficulty thinking	1,470,694	6,105,936	0.16	0.06	2.8
Felt suspicious	575,213	1,623,332	0.06	0.02	4.1
Felt upset	429,786	5,508,418	0.05	0.05	0.9

The risk ratios varied somewhat from year to year, but without clear trends, suggesting variation may have been mostly due to sampling variability. Averages of the risk ratios across the five survey years[18] were computed four different ways:

- Simple average across surveys vs. weighting each survey by its number of respondents
- Computing ratios per past-month user and per past-month use day

[16] The aggregation is provided just for alcohol, cigarettes, cocaine, and marijuana.
[17] The 1985 and 1994A surveys were relatively small, so the 1988 – 1993 surveys include 90% of the respondents who were asked these questions.
[18] 1988, 1990, 1991, 1992, and 1993; there was no survey in 1989.

All four methods produced almost identical aggregate risk ratios which are shown in Table 6, sorted from highest to lowest.

Table 6: Relative likelihood of reporting problems caused by use for marijuana as opposed to for alcohol

	Computed per Past-Month User		Computed per Past-Month Day of Use	
Problems mentioned	Simple Average	Weight Survey by # of Respondents	Simple Average	Weight Survey by # of Respondents
Felt suspicious	3.8	4.0	3.9	4.0
Felt nervous	3.3	3.2	3.3	3.2
Got less work done	2.9	2.8	2.9	2.8
Had difficulty thinking	2.4	2.4	2.4	2.4
Became depressed	2.1	2.1	2.1	2.1
Felt alone	1.6	1.6	1.6	1.6
Problems were hard to handle	1.6	1.6	1.6	1.6
Had health problems	1.5	1.5	1.5	1.5
Felt upset	0.9	0.8	0.9	0.8
Had arguments/fights	0.8	0.8	0.8	0.8
Sought emergency medical help	0.6	0.7	0.6	0.7

These ratios suggest marijuana may be significantly riskier than alcohol with respect to life functioning (getting work done 2.9 and thinking clearly, 2.4) and various measures related to mental and emotional health (ranging from feeling suspicious 3.8 down to feeling that problems are hard to handle, 1.6).

Marijuana was also described as being riskier with respect to physical health, something that was not seen in the 2012 survey, and which should perhaps not be taken too seriously since the rates of reporting physical health problems were very low for both alcohol and marijuana.

Consistent with the 2012 survey, alcohol is seen as being slightly riskier with respect to being upset and getting in physical fights. Alcohol is also seen as more likely to lead to seeking emergency care, but the absolute rates for both drugs were extremely low.

4.2 Problems Reported in the 1994B – 1999 NHSDA Surveys

4.2.1 Summary

The 1994B – 1999 NHSDA surveys asked a series of questions related to problems with drug use. The 1995 – 1998 surveys asked the same seven questions consistently, but the first (1994B) and the last (1999) surveys were slightly different.

- In 1994B the first three questions were the same, but the rest were different, and
- In 1999 the questions were mostly the same, but they were asked in a different format.

In particular, from 1994B – 1998 the prompts were a series of problems, and the respondent was asked to place a mark in a box for each drug that had caused that problem within the last year. In 1999, the respondent was asked to think about the drugs one at a time, and to answer all the questions for that drug before moving on to the next drug.

The substantive finding from these surveys is entirely consistent with that reported for other survey years: The relative rate of experiencing these problems is higher per current marijuana user than per current alcohol user. Indeed, for these questions & survey years, the risk ratios were all above 2.0 and reached as high as 4.5.

These surveys also illustrate a methodological point, namely that modest changes in question wording or format can appreciably affect the proportion of people who say that a substance caused a problem. When those changes are similar across substances, the risk ratio is not affected. While it appears that in one case (drug caused health problems) the change affected the propensity to report problems differently for alcohol vs. marijuana, overall the risk ratios are more stable than are the simple proportions of respondents saying they experienced the problem. For example, the shift in question format from the 1994B – 1998 to the 1999 surveys appeared to cut the rate of reporting problems with drug use taking a great deal of time by about one-third for both marijuana and alcohol, so the risk ratio did not change appreciably. This illustrates one important benefit of focusing the overall analysis on these risk ratios.

4.2.2 Details

The 1994B – 1998 NHSDA surveys described a problem and asked respondents to mark which drug or drugs caused that problem. The first such question in the 1994B survey was:

DR-2.[19] As you read the following list of types of drugs, please mark one box beside each type of drug to indicate whether you had a period of a month or more during the past 12 months when you spent a great deal of time getting the drug, using the drug, or getting over its effects.

The drugs which the respondent could mark were: cigarettes, alcohol, marijuana, cocaine, heroin, hallucinogens, inhalants, anabolic steroids, pain killers, tranquilizers, stimulants, and sedatives.

Five other questions were asked in a parallel fashion:

DR-3. As you read the following list of types of drugs, please mark one box beside each type of drug to indicate whether you have used that kind of drug much more often or in larger amounts than you intended to during the past 12 months.

DR-4. As you read the following list of types of drugs, please mark one box beside each type of drug to indicate whether you have built up a tolerance for the drug so that the same amount of the drug had less effect than before during the past 12 months.

DR-5. As you read the following list of types of drugs, please mark one box beside each type of drug to indicate whether you have often been under the effects or after-effects of that kind of drug in situations where your physical safety was threatened (such as driving a car or motorcycle, using heavy machinery, or swimming) during the past 12 months.

[19] This question is numbered DR-2 because DR-1 asked simply whether respondents had used these drugs within the last year, not whether they experienced any problems with that use.

DR-6. As you read the following types of drugs, please mark one box beside each type of drug to indicate whether your use of the drug has caused you to have problems with your family or friends, problems at work, school, or with the police, or any emotional or psychological problems during the past 12 months.

DR-7a. As you read the following list of types of drugs, please mark one box beside each type of drug. On each line under Column A, mark the "YES" box on the left if you wanted to cut down or stop using that drug in the past 12 months. Mark the "NO" box on the right if you did not want to cut down or stop using that drug or if you did not use that drug in the past 12 months.
DR-7b. For each "YES" box you mark in Column A, please indicate in Column B whether you were able to cut down on or stop your use of that drug every time you wanted to during the past 12 months. Mark the "YES" box in Column B if you were able to cut down on or stop your use of that drug every time you wanted to during the past 12 months. Mark the "NO" box if you were unable to cut down on or stop your use of that drug when you wanted to during the past 12 months.

The last of these questions led to two variables for each drug: WCDALC & WCDMRJ indicating whether the respondent tried to cut down in the past year and ACDALC & ACDMRJ indicating whether they had always been successful.

In the 1995 – 1998 surveys, questions DR-2 – DR-4 stayed the same, but the next four questions changed to.

DR-5. As you read the following list of types of drugs, please mark one box beside each type of drug to indicate whether your use of that drug has often kept you from working, going to school, taking care of children, or engaging in recreational activities during the past 12 months.
ACRDALC & ACRDMRJ

DR-6. As you read the following list of types of drugs, please mark one box beside each type of drug to indicate whether your use of the drug has caused you to have any emotional or psychological problems--such as feeling un-interested in things, feeling depressed, feeling suspicious of people, feeling paranoid, or having strange ideas during the past 12 months.
EMPBALC & EMPBMRJ

DR-7. As you read the following list of types of drugs, please mark one box beside each type of drug to indicate whether your use of that drug has caused you any health problems--such as liver disease, stomach disease, pancreatitis, feet tingling, numbness, memory problems, an accidental overdose, a peristant cough, a seizure or fit, hepatitis, or abscesses during the past 12 months.
HLPBALC & HLPBMRJ

DR-8. As you read the following list of types of drugs, please mark one box beside each type of drug to indicate whether, during the past 12 months, you have wanted or tried to stop or cut down on your use of that drug but found that you couldn't.
UCDALC & UCDMRJ

The 1999 survey also had seven questions on these seven topics, and with the same variable names as in 1995 - 1998, but the way the questions were asked was changed to:

```
Think about your use of marijuana or hashish during the past 12 months as you
answer these next questions.

(DR02C) During the past 12 months, did you have a period of a month or more
when you spent a great deal of time getting, using, or getting over the
effects of marijuana or hashish?
(DR03C) During the past 12 months, have you used marijuana or hashish much
more often or in larger amounts than you intended to?
(DR04C) During the past 12 months, have you built up a tolerance for
marijuana or hashish so that the same amount had less effect than before?
(DR05C) During the past 12 months, has your use of marijuana or hashish often
kept you from working, going to school, taking care of children, or taking
part in recreational activities?
(DR06C) During the past 12 months, has your use of marijuana or hashish
caused you to have emotional or psychological problems - such as feeling
uninterested in things, feeling depressed, feeling suspicious of people,
feeling paranoid, or having strange ideas?
(DR07C) During the past 12 months, has your use of marijuana or hashish
caused you to have any health problems?
(DR08C) During the past 12 months, did you want to or try to stop or cut down
on your use of marijuana or hashish but found that you couldn't?
```

The rates of answering "yes" changed for DR02, DR07, and DR08. That is not surprising for DR07 (drug caused health problems) because the 1995 – 1998 (DR07) version of the question included a list of specific problems – including numbness and memory problems – that was omitted in 1999. Omitting those prompts appeared to reduce the number of people who reported that the drug caused health problems. The wording of DR02 and DR08 did not change so dramatically, but apparently the change in format – from listing problems and then asking the respondent to mark all relevant drugs to instead listing the drug and then asking about each problem – had significant effects on responses to those two questions (DR02 and DR08), but not on the four questions DR03 – DR06.

Table 7 shows the raw proportions and relative problem rates separately for each year, as well as simple averages over years. The averages of the risk ratios across surveys range from 2.3 (used more than intended) to 4.5 (caused emotional or psychological problems). The highest ratios tend to be for the problems that are relatively rare. In absolute terms, the biggest difference was in numbers saying the drug took up a great deal of time (about 0.45 mentions per past-month user for marijuana vs. 0.15 for alcohol).

Table 7: Number of respondents reporting that marijuana and alcohol caused them problems, per past-month user, and (bottom panel) the marijuana vs. alcohol risk ratio (Cells that appear to be appreciably affected by the change in survey format in 1999 are shaded yellow)

	Marijuana mentions per Past Month Marijuana User							
Problems inquired about	1994	1995	1996	1997	1998	1999		
Drug took up a great deal of time	0.41	0.44	0.48	0.45	0.48	0.32		
Used more than intended	0.30	0.31	0.35	0.34	0.34	0.31		
Built up tolerance	0.30	0.33	0.34	0.34	0.36	0.34		
Use kept one from normal activities		0.11	0.14	0.12	0.13	0.11		
Caused emotional/psych problems		0.26	0.22	0.20	0.25	0.22		
Caused health problems		0.14	0.14	0.11	0.13	0.07		
Tried to cut down but failed		0.24	0.27	0.22	0.26	0.18		
	Alcohol Mentions per Past Month Alcohol User							
Problems inquired about	1994	1995	1996	1997	1998	1999		
Drug took up a great deal of time	0.16	0.14	0.14	0.15	0.16	0.09		
Used more than intended	0.14	0.13	0.14	0.15	0.15	0.15		
Built up tolerance	0.12	0.11	0.12	0.12	0.14	0.13		
Use kept one from normal activities		0.04	0.04	0.04	0.04	0.03		
Caused emotional/psych problems		0.05	0.05	0.05	0.05	0.05		
Caused health problems		0.03	0.03	0.03	0.03	0.02		
Tried to cut down but failed		0.08	0.09	0.08	0.08	0.06		
	Ratio of Rate of Problems for Marijuaan Relative to Alcohol							
Problems inquired about	1994	1995	1996	1997	1998	1999	**Avg 94-98**	**Avg 94-99**
Drug took up a great deal of time	2.6	3.0	3.3	2.9	3.0	3.4	**3.0**	**3.0**
Used more than intended	2.2	2.4	2.5	2.3	2.3	2.0	**2.3**	**2.3**
Built up tolerance	2.6	3.1	2.9	2.9	2.7	2.5	**2.8**	**2.8**
Use kept one from normal activities		2.5	3.7	2.7	3.2	3.5	**3.0**	**3.1**
Caused emotional/psych problems		5.4	4.2	3.8	4.8	4.0	**4.5**	**4.4**
Caused health problems		4.1	4.6	3.8	4.5	2.8	**4.2**	**4.0**
Tried to cut down but failed		2.9	3.0	2.7	3.3	2.8	**3.0**	**2.9**

Table 8 returns to the questions from the 1994B survey; since the relative rates depend on question wording, these results are of interest even though the 1994B survey only had 17,809 respondents. The first three risk ratios already appeared in Table 7 above; the bottom five are the new information.

Table 8: Number of respondents reporting that marijuana and alcohol caused them problems, per past-month user, and the marijuana vs. alcohol risk ratio

1994B NHSDA	# of Respondents	# of Respondents	Marijuana mentions	Alcohol mentions	**MJ vs. Alcohol**
Problems inquired about	Mentioning MJ	Mentioning Alcohol	per PM MJ User	per PM Alcohol User	**Risk Ratio**
Drug took up a great deal of time	4,180,219	18,264,550	0.41	0.16	**2.6**
Used more than intended	3,070,937	15,825,006	0.30	0.14	**2.2**
Built up tolerance	3,055,549	13,046,829	0.30	0.12	**2.6**
Used in physically dangerous settings	2,492,425	13,362,587	0.25	0.12	**2.1**
Use caused life problems	2,267,592	8,252,734	0.22	0.07	**3.1**
Tried to cut down	7,938,695	42,394,812	0.79	0.38	**2.1**
Succeeded every time	5,122,099	25,548,022			
Failed at least once (diff of above)	*2,816,596*	*16,846,790*	0.28	0.15	**1.9**
Failed | tried to cut down			0.35	0.40	**0.9**

Per past-month user, marijuana generated about twice as many mentions of problems in situations where physical safety was threatened. That stands in marked contrast to the 2000 – 2012 questions about physical danger, for which the risk ratios were close to 1.0. The difference may perhaps be attributable to the 1994B question including a list of examples "(such as driving a car or motorcycle, using heavy machinery, or swimming)" that was not included in the 2000 – 2012 surveys.

Marijuana use was also about twice as likely to induce attempts to cut down. The failure rate per attempt to cut down was about the same for the two substances, so that also meant that marijuana use was associated with about twice the rate of failed attempts to control use.

The highest ratio in the 1994B survey pertained to whether "the drug has caused you to have problems with your family or friends, problems at work, school, or with the police, or any emotional or psychological problems". Marijuana use was about three times more likely than alcohol use to generate reports of such problems.

4.3 Problems with Impaired Driving Reported in the 1996 NHSDA Survey

The 1996 NHSDA (18,269 respondents) included a non-core module on "driving behaviors" which asked respondents who were 16 or older about drugged as well as drunk driving, with the primary measure being instances of driving within two hours of consuming the substance.

Detailed questions are asked about driving while marijuana- or cocaine-impaired, with a thinner set of questions asked about impairment with alcohol, tranquilizers, stimulants, and sedatives. For all six substances, all people who report both (1) Driving and (2) Having used the drug in question at some point in the past year,[20] are asked:

```
During the past 12 months, have you driven a car or other motor vehicle
within 2 hours after [drinking an alcoholic beverage]?

During the past 30 days, on how many days have you driven a car or other
motor vehicle within 2 hours after [drinking an alcoholic beverage]?
```

The wording here is for the alcohol questions; for the other five drugs, the bracketed phrase is replaced with the name of that drug. These events are referred to below as instances of "impaired" driving since that term is substance neutral, whereas "drunk" and "drugged" refer to alcohol and illicit drugs only, respectively. The survey does not ask about quantities consumed, so not all episodes so labeled necessarily involve significant behavioral impairment. Some might involve just a sip of wine or a single "hit" of marijuana. One would guess this might inflate the stated rates of impairment for both substances but be conservative with respect to the relative rate of marijuana vs. alcohol impairment, inasmuch as alcohol may be used more often for benefits other than intoxication (e.g., for taste, as with wine at dinner), but in the absence of detailed data on amounts used per session, that is just a speculation.

[20] E.g., the variable VMJUSEYR captures the answer to a question in this module about past-year marijuana use. The correspondence with the standard past-year marijuana use variable (MRJYR) is about 95%. Inexplicably, the module does not include its own question about past-year alcohol use. For a fairer comparison, the alcohol column in the table is restricted to respondents who indicated past-year alcohol use on the variable ALCYR.

Table 9 summarizes the results. Alcohol is the greatest source of impaired driving because it is used so often. In 1996 there were ten times as many drivers who reported using alcohol in the last year as reported using marijuana in the last year.[21] However, the number of episodes of impaired driving per past-year user who drives is considerably higher for marijuana (2.6) than for alcohol (0.8), so marijuana generated one-third as many episodes of self-reported impaired driving as did alcohol (33.2 vs. 99.5 million).

Table 9: Numbers Impaired Drivers and Impaired Driving Episodes, by Drug, As Self-Reported in the 1996 National Household Survey on Drug Abuse

	Alcohol	Marijuana	Cocaine	Tranquilizers	Stimulants	Sedatives
Millions of Drivers Who Had Used Drug at Some Point in Past Year	124.8	12.7	2.7	5.4	2.1	4.3
# Who Admit Driving in Past Year Within Two Hours of Using	45.3	6.3	1.8	1.7	1.4	0.7
Proportion Who Drove Impaired	36%	50%	67%	32%	69%	15%
# of Impaired Driving Episodes Reported in Past Month (Millions)	99.5	33.2	2.3	9.1	9.9	2.6
Avg # of PM Impaired Driving Episodes Per Driver Who Had Used Drug in PY	0.8	2.6	0.9	1.7	4.7	0.6

Most of this report has focused on relative rates. These data suggest that among people who drove within the last year, marijuana users generated 2.6 / 0.8 = 3.3 times as many episodes of marijuana-impaired driving per past-year user as alcohol users generated alcohol-impaired driving episodes per past-year alcohol user.

Table 10 replicates these calculations by age and gender for all cells in which there were at least 20 drivers who reported marijuana use within the last year (any use, not just concurrent use or impairment). The relative rate was higher for females than males (5.5 vs. 2.5 overall). There was no consistent relationship with age, except that it was lower for those over 45. Indeed, the relative rate was below 1.0 for those over 45, whereas it was greater than 1.0 for both males and for females for every age group below 45.

[21] The degree of impairment per episode of impaired driving may also be worse for alcohol.

Table 10: Relative Rates of Impaired Driving for Drivers Who Use Marijuana vs. Alcohol

Age	Male	Female	Total
16-17	4.7	10.2	5.6
18-20	3.1	5.4	3.6
21-25	2.6	3.0	3.0
26-29	3.1	2.4	3.1
30-34	2.5	8.6	3.9
35-39	1.6	9.5	2.6
40-44	4.3		4.1
45-49			0.7
50-102			
Total	2.5	5.5	3.3

The next table gives corresponding data for past-*month* alcohol and marijuana users in total, and broken down into the four intensity categories: those using 1 – 3 times in the past month, 4-10 times, 11-20, and 21-30 times. (The total number of episodes is now slightly lower, because those who did not give a valid answer to the frequency of use questions are excluded.)

Not surprisingly, the number of marijuana-impaired driving episodes per person increases sharply with greater frequency of marijuana use from 0.5 episodes per person who used 1-3 times per month up to 11.4 episodes per person who used marijuana on a daily or near-daily basis (21 – 30 times per month). Likewise, frequent drinkers also generate more episodes of impaired driving per capita than do infrequent drinkers, but at every frequency of use, marijuana users produce two to three times as many episodes of impaired driving per person-month as do drinkers.

Table 11: Numbers Impaired Driving Episodes per Driver for Different Frequencies of Use

	Alcohol			Marijuana		
	Millions of Drivers	Impaired Episodes	Episodes per Driver	Millions of Drivers	Impaired Episodes	Episodes per Driver
Used in Past Year	124.8	99.5	0.8	12.7	33.2	2.6
Used in Past Month	91.1	97.6	1.1	7.9	31.3	4.0
Those Who Used						
1-3 Times per Month	42.2	12.8	0.3	3.2	1.7	0.5
4-10 Times per Month	28.8	26.5	0.9	1.9	3.8	2.0
11-20 Times per Month	11.5	23.9	2.1	1.2	8.1	6.7
21-30 Times per Month	8.7	34.4	4.0	1.5	17.7	11.4

Table 12 disaggregates further by age, and expresses the rates per past-month user of that age, not per past-month user who drove.

Table 12: Number of Marijuana-Impaired Driving Episodes per Person, by Age and Frequency of Use

	Past-month frequency of marijuana use (From MJDAY30A)			
Age	Light user (1-3 times per month)	Med1 user (4-10 times per month)	Med2 user (11-20 times per month)	Daily/Near-Daily (21-31 times per month)
16-17	**0.3**	**0.9**	**5.7**	**5.5**
18-20	**0.1**	**1.6**	**6.0**	**9.1**
21-25	**0.3**	**1.9**	**6.5**	**12.2**
26-34	**0.5**	**2.1**	**5.0**	**10.0**
35+	**0.7**	**1.8**	**7.2**	**11.4**

Multiplying these rates by the corresponding numbers of people in each cell in the 1996 NHSDA produces a figure of 31.3 million impaired-driving incidents per month in 1996. That is just a bit below the figure of 33.2 million given in the table above because of losing those who did not give valid answers to the question about past-month days of marijuana use (MJDAY30A).

Multiplying the rates from 1996 given in Table 12 by the numbers of people in each cell in the 2012 NSDUH produces a very rough projection of the number of monthly marijuana-impaired driving episodes in 2012. It is only a rough projection because the rates within each cell could well have changed over time; all that this projection can consider is the increase in the numbers of marijuana users, by age and frequency of use. That projection is 93.6 million episodes, vs. 31.1 million in 1996. That is, this simple exercise suggests that the number of marijuana-impaired driving incidents could have *tripled* over those years, even though the number of past-month users (who were 16+ years old) only doubled from 8.9 million to 18.0 million, because the growth in marijuana use was greatest in cells that had the highest rates of impaired driving. Notably, the number of daily/near-daily users increased by 250% while the number of people using 1-3 times per month increased only 32%. The aging of the marijuana-using population also played a (much smaller) role, since 16-17 year old marijuana users generate fewer impaired-driving incidents than do older users, at any given intensity of use.

Parallel analysis for alcohol projects that alcohol-impaired driving also increased quite a bit (from 97.6M to 146.8M incidents) because there has been a big increase in the amount of frequent drinking by 21-25 year olds, as well as because of population growth generally. Still, it seems plausible that the proportion of impaired driving episodes that pertain to marijuana as opposed to alcohol may well have increased. The figures here would suggest an increase from marijuana-impaired episodes being 31.1 / 97.6 = 32% as numerous as alcohol-impaired episodes in 1996 to 93.6 / 146.8 = 64% as numerous in 2012, although for many reasons these proportions are quite rough estimates.

Returning to the 6.3 million people who admitted driving within 2 hours of using marijuana within the past year, those respondents were also asked:

```
Think about those occasions in the past 12 months when you drove a car
or other motor vehicle within 2 hours after using any marijuana or hashish.
As you read the following list of drugs, please mark one box beside each drug
to indicate how often you used that drug along with the marijuana or hashish.
```

Table 13: Concurrent Use of Others Drug by Marijuana-Impaired Drivers

	Alcohol	Cocaine	Heroin	Hallucinogens	Inhalants	Analgesics	Tranquilizers	Stimulants	Sedatives	Other Drugs
1: Never	16%	80%	94%	84%	93%	94%	92%	89%	92%	86%
2: Rarely	28%	11%	3%	7%	3%	2%	2%	3%	2%	2%
3: Sometimes	40%	5%	0%	6%	2%	1%	3%	4%	3%	1%
4: Often	15%	1%	0%	2%	0%	0%	0%	0%	0%	1%
Bad data/Blank/Multiple Responses	2%	3%	3%	2%	3%	3%	3%	3%	3%	11%

Almost all those who drove impaired by marijuana admitted to instances in which they had also been drinking, and more than half said that such concurrent use before driving happened "sometimes" or "often". This underscores how very difficult it is to label particular episodes of impaired driving, and associated crashes, as due to alcohol or due to marijuana.

Respondents were also asked a related question pertaining to the most recent episode:

```
Think about the most recent time you drove a car or other motor vehicle
within 2 hours after using any marijuana or hashish.  On this most
recent occasion, did you use only marijuana or hashish, marijuana or hashish
with alcohol, or marijuana or hashish with one or more other drugs?
```

30% reported that they had used alcohol along with marijuana on this most recent occasion of marijuana-impaired driving.[22] (About 10% left the question blank, so this proportion rises to 34% of those who answered the question at all.)

People who had driven within 2 hours of using marijuana were asked two questions about perceptions of the degree of impairment:

```
DB-20.  On this most recent occasion when you drove a car or other motor
vehicle within 2 hours after using any marijuana or hashish, how much do you
think your use of marijuana or hashish reduced your ability to drive safely?
```
(variable VLTMJABL)

```
DB-23.  In general, how much do you feel using any marijuana or hashish
reduces your ability to drive safely?
```
(variable VMJABIL)

Marijuana users were confident they could drive well despite recent use. Only about one-in-twenty reported that such use in general or in this most recent instance affected their driving "a lot".

[22] 29% directly through the variable VLTMJALC, and another 1% said they used marijuana along with other drugs, and the list of other drugs included alcohol (based on VLTMJAL1, VLTMJAL2, and VLTMJAL3).

Table 14: Perceptions of People Who Drove While Marijuana-Impaired Concerning the Extent of that Impairment

		VMJABIL: Effect on ability in general			
VLTMJABL:		A lot	A little	Not at all	***ROW TOTAL***
Effect on	A lot	2%	2%	0%	5%
this recent	A little	3%	33%	4%	40%
occasion	Not at all	1%	11%	43%	55%
	COL TOTAL	6%	46%	48%	100%

It is hard to know how accurate such self-assessments are. An optimist might conclude that even though marijuana users often drive soon after using, that behavior creates little risk. Pessimists might worry that not only are those drivers impaired, but they do not even realize how impaired they are. Since the household survey data lack any objective measures of impairment, they cannot shed light on whether the optimists or the pessimists are right.

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Appendix A: Logical Failure of Argument that a Less Harmful Substance Necessarily Should Be Legalized if a More Harmful Substance is Allowed

It has been argued that it is illogical to prohibit a substance that is less harmful than another substance whose use is allowed (e.g., Nutt et al., 2010). However, enforcing that "logic" may harm social welfare or, to put it another way, a benevolent dictator who seeks to maximize social welfare may want to violate that "logic". This basic fact, although rather obvious, has been hard for some to grasp, so this Appendix presents a stylized numerical example to illustrate the point.

Imagine someone invented two new psychoactive molecules. They have identical intrinsic appeal to consumers, and to keep things simple suppose they are neither substitutes nor complements for each other or any other drug. Without loss of generality, let us label the more harmful substance Drug A and the other Drug B.

Suppose further that when underground chemists produce the substances, they achieve 80% yields for both, but different impurities make up the remaining 20% of the illegally produced product. For Drug A's underground production, the remaining 20% has no psychoactive effect, but causes serious organ failure with extended use. For Drug B, the remaining 20% has no particular health harm, but "tastes" lousy either literally (if the drug is taken orally) or abstractly in the sense of reducing pleasure, euphoria, etc. of ingesting Drug B via some other route. So in the short-run, users like underground Drug A just as much as they like legally produced Drug A, but illegally produced Drug A causes serious health-harm. By contrast, illegally produced Drug B is much less appealing than is legally produced Drug B, but the harmfulness per unit is the same whether Drug B is produced legally or illegally.

With that set up, if one were going to prohibit only one of the two drugs, a social planner would prefer to prohibit Drug B, even though it is less harmful per unit use, whether legal or not. One can illustrate this conceptual point with concrete numbers, defining harmfulness as harm per unit of use and total harm as use times harmfulness.

		Drug A	Drug B
Harmfulness if	legal	30	20
	banned	50	20
Consumption if	legal	100	100
	banned	80	50
Total Harm if	legal	3000	2000
	banned	4000	1000

Banning Drug B would reduce its harm to society from 20 * 100 = 2,000 to 20 * 50 = 1,000 even though banning the more harmful Drug A would increase social harm from 30 * 100 = 3,000 to 50 * 80 = 4,000.

Indeed, one could still prefer to ban Drug B even if doing so makes it more harmful per unit of use, say from 20 to 30 on this harmfulness scale, as this second table shows.

		Drug A	Drug B
Harmfulness if	legal	30	20
	banned	50	30
Consumption if	legal	100	100
	banned	80	50
Total Harm if	legal	3000	2000
	banned	4000	1500

The root of what some might think of as a paradoxical result lies in issues pertaining to the larger system (characteristics of illegal production) that have nothing to do with Drug A or Drug B's chemical structure, or their harmfulness to users and/or others when used in pure form. Hence, not only is a univariate measure of harmfulness not an adequate guide to policy, even a fully elaborated multi-factorial characterization of those molecules' harmfulness would not suffice.

A practical example of this principle is drug interactions. For example, cocaine is thought to create greater problems when used in conjunction with alcohol. A social planner could be forgiven, even praised, for recognizing the reality of widespread alcohol use when deciding whether or not to ban cocaine, even though no assessment of cocaine's properties in isolation would consider such an interaction.

There can also be interactions on the supply side. For example, Nutt et al. (2010) rate the total harm of crack as being a 54 against only a 27 for powder cocaine. However, it hardly makes sense to draw a line between the two substances and say crack should be prohibited but not powder cocaine; if one can buy powder cocaine legally, then it is trivial to convert it into crack. So if one really wants crack to be restricted, then it might be entirely sensible to also ban powder cocaine, even if some other substance with a harm rating of 28 is not prohibited.

In sum, even if one could rank substances in terms of harmfulness, it does not logically follow that strictness of control ought necessarily to follow the same rank order.

Appendix B: Problems Reported in the 1979 NHSDA

The 1979 NHSDA did not ask parallel questions about problems with both marijuana and alcohol, so it cannot contribute to the analysis in the body of the report. Nevertheless, it did ask about respondents' perceptions of the potential harms – and potential benefits – of marijuana use. So for completeness they are reported here. The results are broadly consistent with those obtained in the body of the report: marijuana users perceive low risks of physical danger but higher risks of what might be called "performance degradation".

The 1979 NHSDA had 7,224 respondents, of whom 4,017 answered questions about their perceptions of the pros and cons of marijuana use. (The others answered questions about heroin use among friends.) The first question was:

> *"At this time we are going to talk about some of the good and bad effects that marijuana has on people who use it. First the good things. Can you tell me what good effects marijuana has on people who use it?"*

The survey also asked:

> *"Now the other side. What are some of the bad effects that marijuana has on people who use it?"*

SAMHSA describes the NHSDA variables reported in Table B.1 as the edited results of the respondents' answers to these two prompts. Table B.1 gives the proportions of (a) current users, (b) past users, and (c) never users who mention each of these pros or cons of marijuana use. In 1979, 71% of the population 12 and older had never used marijuana, vs. 12% current users and 17% past users, so the proportions for all NHSDA respondents combined (not shown) are generally close to those of never users.

Table B.1 is packed with numbers, so two formatting tricks are used to call attention to the most interesting rows: (1) Effects (good or bad) cited by more than 10% of current users are given in boldface and (2) Instances in which current users and never users disagreed by more than five percentage points are shaded.

The first and rather obvious result is that current users value marijuana mostly for its hedonistic benefits, specifically its ability to help them "relax or unwind" and/or "Get high/Have fun/For kicks". Both responses are cited by about half of current users, but not the same half – as indicated in the third row, which shows that almost 80% cited at least one of those two reasons.

The next two most common benefits users cited were "Medical treatment; glaucoma, etc." (15%) and "Heightens awareness, sensations" (14%). By contrast, on the order of 80% of all Americans – not just users – now support making marijuana available as medicine, suggesting much greater confidence in its therapeutic effects than existed back in 1979.

Benefits that might be perceived of as performance enhancing were rarely cited; just 1% reported that marijuana "Improves energy/job performance."

By contrast, performance degradation was a common complaint, with "Slows reflexes/makes user sleepy" cited most (29%) and "Loss of memory" cited fifth most often (12%). The other three top-five complaints were health-related: "Dangerous to health", "Nausea, dizziness, and appetite change", and "Paranoia, hallucinations, etc.", with "Addictive/habit forming" rounding out the list of problems cited by at least one-in-ten current users. Few (5%) users cited the risk of arrest as a problem.

The disagreements between users and never-users about benefits are predictable. Non-users under-appreciated the benefits valued by users, and were much more likely to describe marijuana as having no important benefits.

The disagreements about problems are more interesting. Non-users were much more likely to describe marijuana as being "Addictive/habit forming" or leading to "Paranoia, hallucinations, etc.", "Loss of self-control & judgment", or "Leads to use of stronger drugs". That fits pro-marijuana advocates' stereotype about non-users' misunderstandings. However, what is perhaps more surprising is that non-users seemed to under-appreciate the problems marijuana creates with regard to "Slows reflex/makes user sleepy", "Nausea, dizziness, and appetite change", and "Loss of Memory." Overall, never users actually mentioned slightly fewer problems with marijuana than did users, and ex-users cited the most problems.

Table B.1: Proportions of Respondents Citing Various Good and Bad Effects of Marijuana Use, Separately for (a) Current Users, (b) Past Users, and (c) Never Users

Good Effects		(a)	(b)	(c)
Variable Name	Short Description	Current Users	Past users	Never Users
GMJRELAX	**RELAX OR UNWIND**	**57%**	**33%**	**12%**
GMJFUN	**GET HIGH/HAVE FUN/FOR KICKS**	**43%**	**39%**	**27%**
	Union of GMJRELAX & GMJFUN	***79%***	***63%***	***35%***
GMJMED	**MEDICAL TREATMENT; GLAUCOMA,ETC**	**15%**	**16%**	**17%**
GMJAWARE	**HEIGHTENS AWARENESS, SENSATIONS**	**14%**	**8%**	**2%**
GMJCNFDN	CONFIDENCE IN SOCIAL SITUATIONS	10%	7%	3%
GMJDEAL	HELPS PEOPLE DEAL WITH PROBLEMS	9%	15%	10%
GMJSLEEP	MAKES USER SLEEPY, SEDATED/TRANQUIL	8%	6%	1%
GMJNOHO	BETTER THAN ALCOHOL/NO HANGOVER	8%	6%	1%
GMJAPPET	IMPROVES APPETITE	5%	1%	0%
GMJNONE	NO GOOD EFFECT	4%	13%	26%
GMJSEX	INCREASES SEX DRIVE, PLEASURE	3%	1%	0%
GMJJOB	IMPROVES ENERGY/JOB PERFORMANCE	1%	1%	1%
Bad Effects		(a)	(b)	(c)
Variable Name	Short Description	Current Users	Past users	Never Users
BMJREFLX	**SLOWS REFLEX/MAKES USER SLEEPY**	**29%**	**19%**	**9%**
BMJHLTH	**DANGEROUS TO HEALTH**	**20%**	**18%**	**23%**
BMJDIZZY	**NAUSEA, DIZZINESS, APPETITE CHNG**	**19%**	**13%**	**6%**
BMJHALLU	**PARANOIA, HALLUCINATIONS, ETC.**	**16%**	**20%**	**25%**
BMJMEMR	**LOSS OF MEMORY**	**12%**	**5%**	**3%**
BMJHABIT	**ADDICTIVE/HABIT FORMING**	**11%**	**21%**	**20%**
BMJNONE	NO BAD EFFECT	8%	5%	1%
BMJCONTR	LOSS OF SELF CONTROL & JUDGMENT	8%	13%	17%
BMJMOOD	CAUSES NEGATIVE MOOD	7%	9%	6%
BMJJOB	DECREASES ABILITY AT SCHOOL/JOB	7%	8%	4%
BMJAPTHY	APATHY/UNCARING ATTITUDE	7%	7%	5%
BMJDRIVE	AFFECTS DRIVING	5%	9%	5%
BMJEXPNS	USE IS EXPENSIVE, WASTES MONEY	5%	5%	3%
BMJILLEG	USE IS ILLEGAL/CAN BE ARRESTED	5%	3%	1%
BMJSTRGR	LEADS TO USE OF STRONGER DRUGS	2%	11%	12%
BMJCRIME	LEADS TO OTHER CRIME	0%	2%	5%

The 1979 NHSDA went on to ask a curious set of questions about respondents' perceptions of the relationship between marijuana use and goal achievement. The opening question was:

> *"Let me introduce the next question by telling you about some imaginary persons. All of them are the kinds of people who work hard on the job or around the house because they have certain goals for themselves or for their families. Thinking of these kinds of people, do you think that their chances of becoming involved in using marijuana are the same as everybody else, more than everybody else, or less than everybody else?"*

Not surprisingly, the proportion of respondents who believed that hard work was a protective factor against marijuana use was much higher for never-users (54%) than for past (43%) or current (21%) marijuana users, although all three groups agreed that hard work would not make someone more likely to get involved with marijuana. (Just 4% of each group gave that answer.)

The survey then described three hypothetical hard-working people who started using marijuana with varying degrees of intensity:

- "every day, and at night, [and] is almost always high" (Terry),
- "a little marijuana every night and enough more on weekends to stay high" (Pat), and
- "smokes marijuana only on weekends and never stays high for long" (Robin).

The survey asked whether the respondent thought each of these people would stop caring or working as hard. If the respondent said yes, then the respondent was asked two additional questions: (1) Had the respondent himself or herself ever stopped caring or working so hard because of such use? and (2) Had that ever happened to someone the respondent knew?[23] Naturally never-users always answered "no" to whether their own use had had such an effect.[24]

Table B.2 shows the results, expressed as proportions of the number of (a) current users, (b) past users, and (c) never users who answered the first question about each hypothetical person.[25]

Some patterns in the results are predictable. E.g., never users were the most likely and current users the least likely to believe the hypothetical person would be adversely affected. Also, in every case, respondents were more likely to think the hypothetical person would suffer harms

[23] Exact wording for the Terry questions was: "Now suppose that one by one, each of these hard-working people starts experimenting with marijuana. After a while, the first one, whom we will call Terry, is smoking marijuana every day, and at night, is almost always high. Do you think it is likely that this kind of steady use of marijuana will make a hard-working person like Terry stop caring and not try as hard, or do you think that it will make no difference?" (Variable MJCAREMR).
Respondents who answered "yes" to MJCAREMR were asked whether "There was a time when steady use of marijuana made me stop caring and not try as hard." (Variable MJCRMORE) and whether "There was a time when steady use of marijuana made someone I know stop caring and not try as hard." (Variable MJOTHMOR)

[24] See Lubman et al. (2007) and Yap et al. (2012) for a more modern version of this vignette-based surveying.

[25] Slightly different numbers of people answered for each hypothetical person. E.g., 14.64 million current users answered the first question about Terry, vs. 14.71 and 14.67 million for Pat and Robin.

from marijuana than they were to admit having such problems themselves – which is suggestive of an optimism bias or illusion of control.

Nevertheless it is interesting that current users made the sharpest distinctions based on intensity of use. While they were only modestly less likely than never-users to think Terry's heavy daily use would have adverse effects (53% vs. 83%), they were much less likely to think that Robin's weekend use had such effects (4% vs. 41%). Past users fell in between, but more or less agreed with never-users that marijuana use harmed performance when it was daily and heavy (77% vs. 83% for Terry) or even daily and light (48% vs. 67% for Pat), but gave answers closer to those of current users when it came to the harms of weekend use (15% vs. 41% for Robin).

So all groups, including experienced users, agreed that daily heavy use has adverse effects, but there was disagreement as to whether less intense patterns of use was likely to cause problems.

Table B.2: Proportions of Respondents Believing Marijuana Use at Various Levels Would Reduce Motivation/Effort for Hypothetical Subject, Had that Effect on Them, & Had That Effect on Someone They Knew

Respondent	Hypothetical person	Level of Use	Thought hypothetical person would stop caring/trying as hard	Admitted own use had such effect	Knew of someone else affected by such use
a) Current Users	Terry	Almost always high	53%	23%	39%
	Pat	Daily, lighter use	18%	10%	15%
	Robin	Weekend use	4%	1%	1%
b) Past Users	Terry	Almost always high	77%	14%	52%
	Pat	Daily, lighter use	48%	10%	32%
	Robin	Weekend use	15%	5%	11%
c) Never Users	Terry	Almost always high	83%	NA	23%
	Pat	Daily, lighter use	67%	NA	17%
	Robin	Weekend use	41%	NA	10%