Medical Marijuana in Wisconsin: A Cost-Benefit Analysis

Prepared for Yogesh Chawla, Dane County Supervisor

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Executive Summary

At the request of Yogesh Chawla, a member of the Dane County Board of Supervisors, our team performed a cost-benefit analysis of medical marijuana legalization alone and medical marijuana legalization with a decriminalization component. In the following report, we estimate the social and economic costs and benefits of these two policy alternatives over a five-year time horizon. We also perform a sensitivity analysis using a Monte Carlo simulation to assess the robustness of our estimates. Our first policy alternative legalizes medical marijuana in Wisconsin. Our second alternative legalizes medical marijuana in Wisconsin with statewide decriminalization of the possession of small quantities of marijuana. Over five years, we find that legalizing medical marijuana in Wisconsin yields positive net benefits with a net present value of $1.11 billion. We also find that legalizing medical marijuana with decriminalization of marijuana possession yields net benefits with a net present value of $1.14 billion. Accordingly, we recommend that the State of Wisconsin adopt legislation to legalize medical marijuana and decriminalize the possession of small quantities of marijuana.

Medical marijuana legalization with decriminalization provides larger net benefits because it achieves the same medical and health-related outcomes as stand-alone medical marijuana legalization while reducing certain criminal justice costs. We monetize eight benefit and cost categories, including administrative costs and benefits, consumer surplus benefits, criminal justice benefits, opioid addiction and overdose risk reduction benefits, fatal accident reduction benefits, and certain health costs. The largest benefit categories are the reduction in aggregate fatal accidents and consumer surplus benefit. The largest estimated cost category is the increased adult ER visits. Net benefits or costs associated with recreational marijuana possession and use are outside of the scope of this analysis. An analysis of recreational marijuana possession and use would likely involve additional benefit and cost categories.

In addition to our central recommendation, we recommend that the state launch and sustain a targeted public health and safety awareness campaign and evaluate the implementation and performance of the program after two years. We further recommend that state agencies responsible for implementing and administering the proposed legalization and decriminalization policy adopt best practices from other states that have successfully implemented similar policies.
**Introduction**

Wisconsin residents do not currently have legal access to marijuana for either recreational or medical use. Bills related to the legalization of marijuana for either medical or recreational use have been introduced but have not passed in the state legislature. Public opinion is increasingly in favor of, at a minimum, legalization for medical use. We present the following cost-benefit analysis regarding the implementation of medical marijuana in Wisconsin, both with and without statewide decriminalization, to help stakeholders evaluate the potential social impacts of a medical marijuana program in the state. This report provides issue background, a description of proposed alternatives to current policy, estimated costs and benefits of each policy alternative, and a description of the methodology we used to complete the analysis. A final discussion and recommendation section summarizes the net present value of a medical marijuana program in Wisconsin and provides a number of recommendations for the state policymakers.

**Background**

Since 1970, marijuana has been classified as a Schedule I substance under the Controlled Substances Act, the statute that establishes the U.S. government’s drug policy and regulates the manufacture, distribution, and use of certain substances (91 U.S.C. § 513). Schedule I drugs are deemed to have no accepted medical use and a high potential for abuse. Crimes involving these drugs can result in significant criminal and civil penalties, including imprisonment and fines (Drug Enforcement Agency 2018). Although synthesized versions of some marijuana components, namely THC and cannabinol, have been reclassified by the federal government, the possession of the marijuana plant as a whole remains largely prohibited under federal law in all but a few circumstances (Haffajee et al. 2018).
Current federal policy remains highly restrictive with respect to marijuana, including its possession and use for medical purposes. On January 4, 2018, the Attorney General of the United States issued a memo clarifying the current administration’s position on marijuana enforcement [Appx. A]. This memo rescinded prior guidance from the Justice Department that had indicated that the federal government would not prioritize marijuana enforcement in jurisdictions where it was otherwise legal. The revised guidance instructed prosecutors to weigh the relevant facts of the case against the seriousness of the offense and the deterrent effect of prosecution before initiating an enforcement action. Ultimately, the memo gave individual U.S. Attorneys discretion over the prioritization of marijuana-related indictments. At present, the only legal barrier preventing the federal government from enforcing federal marijuana law is the Rohrabacher-Blumenauer Amendment, which prohibits the federal government from using federal funds to interfere with the implementation of state medical marijuana laws (Rosenblum 2018).

Marijuana’s classification as a Schedule I substance is also a barrier to conducting the type of clinical and scientific research required to secure FDA approval for medical products and devices. Limited federal funding for medical marijuana research and the federal government’s monopoly on the supply of marijuana for use in clinical trials has almost completely eliminated the opportunity for clinically driven medical marijuana research. The absence of consistent and comprehensive federal medical marijuana policy has also affected the safety of marijuana products and physician willingness to recommend marijuana to patients. As a result, policymakers are missing critical information about efficacy, dosage, adverse side effects, and product availability. In addition, it has resulted in minimal federal oversight of medical marijuana regulation, marketing, and use. In states that have liberalized marijuana consumption,
either for recreational or medical purposes, these responsibilities are assumed almost entirely by
the state (Haffajee et al. 2018).

While marijuana remains illegal at the federal level, more than 25 states and the District of
Columbia have legalized marijuana for recreational or medical purposes. Annual surveys
conducted by the Pew Research Center have shown that consistent majorities have supported
marijuana legalization since about 2010. As of October 2018, 62 percent of Americans support
marijuana legalization according to Pew (Geiger & Hartig 2018). In Wisconsin, numerous local
governments have decriminalized marijuana possession and ballot referenda regarding various
types of marijuana legalization in the 2018 elections drew widespread support [Appx. S]. In
general, marijuana use has increased as marijuana has become more socially and legally
acceptable. According to the National Survey on Drug Use and Health, more than 10 percent of
Americans age 12 and older used marijuana at least once in 2016 (SAMHSA 2018). Spending on
marijuana has also increased. In states that have legalized marijuana, marijuana sales now exceed
$8 billion and by 2025 total nationwide marijuana sales could be as large as $25 billion. In
tandem with increased spending on marijuana products, state revenues generated from taxes,
fees, and licenses are also expected to grow. In 2017, marijuana tax revenues totaled $745
million. These revenues, which are often used to fund special school programs, public health
campaigns, and targeted law enforcement programs, are expected to reach $4.3 billion by 2020
(Haffajee et al. 2018). The popularity of marijuana and its perceived fiscal benefits suggest that
more states will liberalize marijuana policies in the future. Ultimately, a more comprehensive
federal strategy may replace the current patchwork of state and local policies, but such a change
is unlikely in the near future (Kreit 2014).
Description of the Task
Increasingly, legalization of medical marijuana is under consideration in Wisconsin. We use resources from the academic literature and the experiences of other states to estimate the costs and benefits of implementing a medical marijuana law with and without decriminalization. Our analysis considers both administrative and social costs and benefits. We predict the net present value to Wisconsin over the first five years of implementation of medical marijuana legalization.

Current Policy: Wisconsin
Wisconsin state law currently prohibits a person from manufacturing, distributing, or delivering marijuana. It also prohibits a person from engaging in certain related conduct, including possessing marijuana in any amount, using drug paraphernalia, or possessing drug paraphernalia with the intent to produce, distribute, or use marijuana (Wis. Stat. 961.34 (2)). First time marijuana possession offenses are considered misdemeanors punishable by a fine of up to $1,000 or imprisonment for up to six months; subsequent offenses are considered felonies punishable by a fine of up to $10,000 or imprisonment for up to 3.5 years (Wis. Stat. 939.50(3)(i); Wis. Stat. 961.14(3g)(em)). Although prohibited by state law, some Wisconsin municipalities, including Milwaukee and Madison, have passed local ordinances that reduce the criminal penalties for first time marijuana possession. In Milwaukee, for example, first time offenders who possess less than 25 grams of marijuana receive the equivalent of a municipal ticket (SCAODA 2016). A total of 12 municipalities in Wisconsin have ordinances that decriminalize marijuana possession with fines ranging from $50 to $1,000 (Maier et al. 2017).

Since 2013, members of the Wisconsin State Legislature have introduced bills to legalize medical and recreational marijuana. Legislation for these purposes was first introduced in 2013.
and then again in 2015 (Wisconsin A.B. 810; Wisconsin S.B. 789). The most recent attempt to legalize medical marijuana was in 2017, when Assembly Bill 75 (AB 75) was introduced. AB 75 would establish a medical use defense for individuals who possess marijuana and have registered with the Department of Health Services as having one of several qualifying debilitating medical conditions or treatments (Wisconsin A.B. 75). AB 75 was defeated by a vote of 34 to 59 after it reached the Assembly floor. With the exception of AB 75, all other marijuana related legislation in Wisconsin has stalled in committee.

Although the Wisconsin Legislature has not shown support for medical marijuana legislation, voters in Wisconsin have been relatively supportive of medical marijuana. In the November 2018 general election, more than a dozen counties and two cities had non-binding resolutions asking voters to vote in favor or opposition to various marijuana-related changes to existing law. As mentioned previously, these recent state referenda suggest widespread constituent support for MMLs. These results were largely consistent with public opinion polling by Marquette University Law School, which found in August 2018 that 61 percent of Wisconsin respondents supported marijuana legalization (Behm 2018).

While Wisconsin has not moved forward with any marijuana legislation, several surrounding states have taken steps to legalize either medical or recreational marijuana. Two of Wisconsin’s border states, Minnesota and Illinois, have legalized access to medical marijuana and are years into their program implementation; a third state, Michigan, voted to legalize recreational marijuana in the November 2018 midterm elections (Angell 2018). Medical marijuana laws in Wisconsin’s neighboring states differ. While Minnesota allows medical marijuana, patients are only allowed to consume concentrated products, and Illinois’ medical marijuana law allows
patients to utilize both flower, a colloquial term for the marijuana plant in a smokable form, and concentrated variations of medicinal marijuana. Michigan law allows both forms.

**Alternatives: Medical Marijuana with and without Decriminalization**

We evaluate two alternatives for statewide medical marijuana legalization: legalization with and without decriminalization. Of the 22 states that have only legalized medical marijuana, 10 have also decriminalized marijuana possession [Appx. Q]. To analyze the potential costs and benefits of medical marijuana legalization, we use data from these states, as well as information from other sources, to establish appropriate cost and benefit categories and their monetization for our two alternatives. For a full list of policies by state, see Appendix U.

Our first policy alternative (medical legalization without decriminalization) builds on the legislation of other states, as well as Wisconsin State Representative Chris Taylor’s 2017 Assembly Bill 75. We use the experiences of other states and the fiscal estimates prepared by seven Wisconsin departments as the basis for our predictions.

**Alternative 1: Medical Marijuana without Decriminalization**

Under this alternative, patients with qualifying conditions outlined in statute could legally obtain and use marijuana to treat their conditions. Example conditions include cancer, HIV/AIDS, chronic pain, seizure disorders, and post-traumatic stress disorder. Patients would be required to seek a recommendation for marijuana from their doctor. After securing a recommendation, qualifying patients register with the Department of Health Services (DHS). Following approval from DHS, patient information is included in the marijuana registry and the patient receives a medical marijuana card that allows him or her to purchase marijuana from a Wisconsin dispensary. Dispensaries would be allowed to sell both flower and concentrated products.
Operators would be required to obtain a license from the state and pay licensing fines. Regulation of this program would fall under the purview of DHS. This alternative also includes a public health campaign to educate practitioners, patients, and youth: practitioner and patient education would be focused on explaining the program and its requirements; youth education would focus on potential harms of marijuana use during adolescence.

**Alternative 2: Medical Marijuana with Decriminalization**

The marijuana program under this alternative is identical to the medical marijuana program described in the preceding section but adds a criminal justice reform component. Statewide marijuana decriminalization would follow local ordinances such as those in Milwaukee or Madison, where simple possession small amounts of marijuana (25 and 28 grams, respectively) is punishable with a small municipal fine. Advocates for decriminalization suggest that such a policy would lead to a decrease in law enforcement and criminal justice costs, reduced impacts from racial disparities in low-level possession citations, and a better alignment between the severity of punishment and the crime (Greenwald 2009). Opponents of decriminalization anticipate less law enforcement capacity to track down higher-level suppliers and an increase in the number of people using marijuana and other substances.

**BENEFITS**

We estimate benefits from administrative fees, health benefits measured using patient demand and consumer surplus, reduction in opioid overdose and addiction risk, reductions in the number of traffic fatalities, and decreased incidence of criminal justice costs (decriminalization only). We use a five-year valuation period and a social discount rate of 3.5 percent in our analysis.
Benefits Based on Administrative Fees and Costs
Wisconsin’s Department of Health Services (DHS), Department of Administration (DOA), and Department of Workforce Development (DWD) would incur administrative costs related to the implementation and maintenance of the state’s medical marijuana registry, the oversight of marijuana dispensaries, the inspection of marijuana products, and changes to the state’s fair housing rules [Appx. L]. These expenses would be offset by a $75 biennial fee paid by each qualifying patient on the state’s medical marijuana registry. To estimate any potential social benefits or costs associated with these fiscal estimates, we estimate the program’s net fiscal cost by subtracting the estimated annual expenditures from the estimated fee revenue. Our estimates show that revenue from the biennial fees would exceed annual administrative expenses, resulting in surplus revenue. To calculate the resulting net benefit, we treat the fee revenue as a transfer and only consider the avoided deadweight loss from avoided taxes as a social benefit. We use a marginal excess tax burden of 0.25 and multiply the net program revenues by this value to estimate the total net benefits associated with the program’s fees and expenses. Applying our standard discount rate, we estimate a total, five-year discounted administrative benefit of about $792,000, with a plausible range between -$105,000 (a cost) and $1.76 million.

Benefits to Medical Patients (Demand)
Research to evaluate and validate the use of marijuana as a treatment for various medical conditions is still emerging and inconclusive for most conditions. Because comprehensive research regarding measurable health benefits from marijuana is unavailable, we do not use health-related measures (such as quality-adjusted life years) to estimate the medical benefit provided to each patient using marijuana to treat a certain condition. Rather than using such measures for each medical condition, we instead estimate the aggregate consumer willingness to
pay for medical marijuana. The logic common to cost-benefit analysis is that a consumer’s willingness to pay for a product in a normally functioning market represents the value of the benefit, in dollars, that consumers receive from the good (Boardman et al. 2017). We predict the level of demand in the potential medical marijuana market in Wisconsin, which represents an estimate of the state’s consumers’ aggregate willingness to pay. The total benefit to consumers, or, the economic utility they receive from consuming the treatment, is conceptualized as the consumer surplus in the market, or the total amount that consumers would be willing to pay for the good above their actual payments at the market price.

Unlike the normal health care market, where prescription drug prices facing consumers are often offset by cost-sharing mechanisms like copays through health insurance plans, medical marijuana is not eligible for insurance coverage. Consequently, the market for the drug and prices for consumers would not be distorted by health insurance. Therefore, we judge our estimate of the consumer surplus in the medical marijuana market to be a reasonably reliable estimate of the total patient benefit from the provision of medical marijuana.

To predict consumer surplus in the medical marijuana market we estimate: 1) the number of medical marijuana users in the emerging Wisconsin market; 2) the average quantity sold to each patient per month (in grams); 3) the price of medical marijuana (per gram); 4) the price elasticity of demand for medical marijuana; and 5) the assumed functional form of the demand curve. See Appendix I for the methodology used to predict these parameters and the resulting consumer surplus in the predicted market.
We project cumulative benefits in terms of patient utility (as represented by aggregate consumer surplus in the predicted market for smokable marijuana) of about $233 million, with a plausible range between $65.5 million and $566 million.

This estimate does not include marijuana products other than smokable flower, such as oil concentrates and infused edibles. For these products, due to their widely varying forms, we did not find a consistent relationship between price, potency, and quantity by weight or mass, which limited our ability to apply our methodology for estimating consumer surplus [Appx. I]. Our prediction of medical marijuana benefits is conservative because it does not include the potentially sizeable market for marijuana concentrates and infusions. Illinois’ most recent sales report indicated that 52 percent of total marijuana sales were concentrates and infusions, implying that there may be a large “add-on” benefit we do not observe in our base estimate.

Using a basic methodology to extrapolate the consumer surplus of concentrates and oils from the consumer surplus in the flower market [Appx. I], we project the benefits from these products to be centered at $197 million, with a plausible range of $44.8 million to $576 million. However, because of the data availability and methodological limitations, we do not include these estimates in our prediction of the medical benefits of implementing medical marijuana legislation.

**Benefits Based on Alleviated Criminal Justice Enforcement Costs (Decriminalization Only)**

Many states that have medical marijuana also have statewide decriminalization [Appx. Q], and voters in counties throughout Wisconsin recently voted overwhelmingly in favor of both medical and recreational marijuana [Appx. S]. Under decriminalization, costs related to arresting, processing, and penalizing those who possess marijuana would be reduced. We estimate that benefits would accrue from reduced jail sentences, arrests, and court cases. Over a period of five
years and discounted, we project that alleviated criminal justice enforcement costs would result in savings of **$38.0 million**, with a plausible range between **$35.8 million** and **$40.6 million**. (See Appendix M for a detailed explanation of this calculation.)

**Benefits Based on Reduced Opioid Addiction and Fatal Overdose Risk**

In addition to personal harms, opioid addiction and fatal overdoses have negative externalities. Externalities are effects on third-parties due to the consumption or production of a good (Boardman et al. 2018). These externalities include health care costs, criminal justice costs, and lost productivity costs. We estimate any benefits for avoiding these externalities separately from consumer demand for, and utility from, marijuana as a substitute for opioid use, and we consider the patient’s perception of his or her risk of addiction to be accounted for in the consumer surplus calculation.

The number of deaths from opioid-related overdoses continues to increase in Wisconsin, reaching 833 deaths in 2017, even as the number of opioid prescriptions has decreased by more than 20 percent (Department of Health Services 2018). There is broad consensus that current rates of opioid abuse are an epidemic and a public health crisis. While there is limited clinical trial evidence for marijuana as a treatment for any disease, there is compelling medical evidence for marijuana as a treatment for chronic pain, and growing evidence for marijuana as a substitute for opioid medication in the treatment of chronic or intractable pain. Surveys of medical marijuana patients in both Canada and Michigan have found that patients self-report using medical marijuana as a substitute for prescription opioids, with many patients substantially decreasing or completely eliminating their use of opioid pain medication (Lucas & Walsh, 2017; Boehnke et al. 2016).
Using data from Minnesota’s intractable pain study (2018), we estimate reduced risk of opioid addiction and fatal opioid overdose for the first five years of a medical marijuana program in Wisconsin. In year five and subsequent years, we find that a medical marijuana program is likely to result in an average of 1,175 reduced addictions annually and an average annual reduction of 49 reduced fatal overdoses. Reduced additions and fatal overdoses are likely to increase proportionally to registry population increases during years one through five. We estimate benefits from these avoided harms of **$291 million** over five years, with a plausible range between **$108 million** and **$503 million**. (See Appendix J for a detailed explanation of the calculation, including shadow prices for addiction and overdose-related fatalities.)

**Benefits from a Reduction in Fatal Car Accidents**

Traffic fatalities are a leading cause of death in Wisconsin and evidence that cannabis use by drivers has increased suggests that concerns about drugged driving may be well-founded. However, a review of the accident literature finds that the isolated effects of marijuana use on driving performance are mixed and inconsistent, especially when accounting for demographic factors including age and gender. The literature clearly finds, however, that medical marijuana laws are associated with a reduction in aggregate traffic fatalities (Anderson et al. 2013; Santaella-Tenorio et al. 2017).

Studies examining the isolated effects of marijuana intoxication on driving performance find either moderate increases in crash risk or statistically insignificant increases in crash risk when drivers are under the influence of marijuana (Hostiuc et al. 2018). A large, nationally representative case-control study conducted by the National Highway Traffic Safety Administration (NHTSA), however, found that that when demographic factors and alcohol
consumption were considered, drivers under the influence of marijuana were not more likely to be involved in an accident than drivers in the control group (Compton 2017). In view of the uncertainty in the literature and the potential impacts marijuana may have on the consumption of other substances, our analysis uses research that examines the impact of medical marijuana laws on total traffic fatalities, not just those that result from marijuana use. This line of research uses difference-in-differences across states to measure the impact of medical marijuana laws on aggregate traffic fatalities. These studies find a statistically significant decrease of roughly 10 percent in the rate of traffic fatalities following the implementation of medical marijuana laws (Anderson et al. 2013). In states with operational dispensaries, the reduction is a more modest 2.7 percent (Santaella-Tenorio et al. 2017). The majority of this decrease is likely due to substantial substitution effects between marijuana and the consumption of alcohol, although the causal link between the two remains somewhat weak with respect to traffic accident risk.

Our estimates of the effect of medical marijuana legalization are based on estimates of aggregate traffic fatalities in states with medical marijuana laws and operational dispensaries. We estimate that legalization of medical marijuana in Wisconsin would result in a significant decrease in the number of aggregate traffic fatalities, leading to a net benefit of $586 million, with a plausible range from -$731 million to $1.84 billion. (A further review of the literature and our calculation of avoided costs can be found in Appendix P.)

**COSTS**

The costs of implementing medical marijuana include an increased incidence of children sent to emergency departments, implementation of a public health and awareness campaign, and an increased incidence of adults sent to emergency departments (decriminalization alternative only).
Costs from Increased Marijuana-Related Pediatric Emergency Department Visits

Studies have shown an increase in exposures to marijuana in children under the age of 12 following the legalization of marijuana for medical purposes (Wang et al. 2013; Cao et al. 2016; Onders et al. 2015). The majority of these exposures affected very young children and were associated with edible marijuana products. We use information from the literature on pediatric exposures to marijuana and additional Wisconsin-specific population and cost of healthcare data to predict an expected increase in marijuana exposures in children under the age of 12 and estimate the costs of those exposures. From these data, we estimate that an average of 9.75 additional pediatric exposures to marijuana would require treatment that originates in an emergency care setting at an average five-year total cost of $284,000, with a plausible range of $280,000 to $287,000. (See Appendix O for a detailed explanation of this calculation.)

Costs from Increased Marijuana-Related Adult Emergency Department Visits (Decriminalization Only)

While there are no studies that claim significant changes in emergency department (ED) visits as a result of medical marijuana legalization, one study from 1993 found that decriminalization increased ED “episodes” for marijuana (Model 1993). The study found that marijuana mentions increased 56 to 64 percent in states with decriminalization compared to those without decriminalization (Model 1993). This increase is estimated to increase ED visits by 7.75 per 100,000 people. From this we estimate the costs from these increased ED visits to be $5.15 million, with a plausible range of $5.09 million to $5.21 million. This study also showed that there was a decrease, albeit a smaller decrease, in non-marijuana related drug ED episodes in states that decriminalized marijuana. Based on the vague nature of non-marijuana drug related episodes, however, we do not estimate this potential benefit. Thus, this calculation is a
conservative measure that likely overestimates costs associated with ED visits. See Appendix N for a detailed explanation of the annual calculation.

Costs from A Public Health/Awareness Campaign
We include a cost estimate range for a public health and awareness campaign to spread information to medical marijuana users, doctors, caregivers, and adolescents. Similar campaigns have been used in other states such as Alaska (Alaska Department of Health and Social Services 2015) and California (California Department of Public Health). We use Colorado’s public health and awareness campaign as a model because of the literature available about it.

In the “Good to Know Colorado” campaign, “Key messages educate the public about the health effects of marijuana and key laws that prevent youth marijuana initiation. Additional messaging promotes safe storage, warns about marijuana use during pregnancy and while breastfeeding, and presents information about the dangers of underage marijuana use” (Ghosh et al. 2015). We recommend that the Wisconsin program also address drugged driving through a targeted outreach campaign because drugged driving qualifies as an Operating While Intoxicated (OWI) offense under Wisconsin state laws. To address potential harms of marijuana effectively, a campaign in Wisconsin should cover “access, availability, and use by youths,” “drugged driving,” “dependence and addiction,” “consumption of marijuana products with unwanted contaminants and uncertain potency,” and “concurrent use of marijuana and alcohol” (Pacula et al. 2014).

The “Good to Know Colorado” campaign cost Colorado an estimated $5.7 million over the entirety of the multi-year campaign (Hughes 2015). For a Wisconsin public health campaign, we
estimate a uniform range of values using a point estimate of $3.5\text{ million}$, with a plausible range of $1.5\text{ million}$ to $5.5\text{ million}$.

**NON-MONETIZED VALUES**

In addition to the costs and benefits estimated above, we identified but declined to monetize several other potential costs and benefits that were discussed in the popular literature. These non-monetized values include the potential change in marijuana use disorder, adolescent use of marijuana, and policing costs following the implementation of either alternative.

Legalizing any form of marijuana raises concerns about the potential for increased marijuana abuse, or marijuana use disorder. National data and replicated studies examining the effect of medical marijuana legalization on increases in marijuana use disorder have conflicting, and often statistically insignificant, claims. We therefore assume no change in the rate of marijuana use disorder due to medical marijuana legalization because of the lack of direct statistical correlation and conflicting research results on this topic. Increased adolescent use of marijuana due to medical legalization is also a concern. However, many studies have examined these effects and found no statistically significant effect on adolescent use of marijuana due to the availability of medical marijuana (Sarvet et al. 2018; Hasin 2017). (See Appendix D for additional details on marijuana use and abuse.)

A common political concern related to the legalization of medical marijuana is that the establishment of dispensaries with large quantities of marijuana products will cause rates of violent and property crime to increase in areas surrounding the dispensaries. However, studies have shown that rates of violent and property crime either stay the same or decrease in areas near sites of medical marijuana implementation. Accordingly, we did not estimate costs an increase in
policing costs in this analysis. (See Appendix E for additional information regarding rates of violent and property crime near medical marijuana dispensaries.)

The state would also have to facilitate law enforcement training on the new cannabis regulations and enforcement parameters. Police officers must be trained on how and when to engage a person using marijuana and how to determine their medical usage status. Under the decriminalization alternative, training would distinguish how to impose municipal citations for basic marijuana possession as opposed to possession of amounts greater than the decriminalized threshold. For this analysis, we do not consider this training to be a cost in addition the state’s status quo. The state already mandates that any law enforcement officer complete 24 hours of training annually to obtain recertification, with 4 of those hours based on “curricula based upon model standards promulgated by the [Wisconsin Law Enforcement Standards Board]” (Wis. Stat. § 165.85(4)(a)). We assume that training on revised marijuana statutes would be included within these mandated hours and do not estimate an additional cost for police training in this analysis.

**ANALYSIS AND RESULTS**

Many parameters in our analysis have some degree of uncertainty. To account for those uncertainties, we conduct a Monte Carlo simulation with 10,000 trials for each alternative. Monte Carlo simulations involve specifying distributions for uncertain parameters, taking random draws from these distributions for each observation, and generating a distribution of net benefits for all observations (Boardman et al. 2017). The appendices to this report clarify and justify the distributions we use for uncertain parameters.
Using a 3.5 percent social discount rate over five years, we find that in all 10,000 trials for both the decriminalization and non-decriminalization alternatives, 100 percent of trials show positive net benefits. The distribution of benefits from this analysis is presented below:

*Figure 1: Net Present Value, Non-Decriminalization Alternative*
Mean, minimum, and maximum values from this analysis are presented in the table below; categories included in the decriminalization alternative are italicized:

**Table 1: Cost and Benefit Category Ranges**

<table>
<thead>
<tr>
<th>Cost/Benefit Category</th>
<th>Mean (millions of dollars)</th>
<th>Minimum (millions of dollars)</th>
<th>Maximum (millions of dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrative benefits</td>
<td>0.79</td>
<td>-0.11</td>
<td>1.76</td>
</tr>
<tr>
<td>Justice benefits (Decriminalization Only)</td>
<td>38.0</td>
<td>35.8</td>
<td>40.6</td>
</tr>
<tr>
<td>Consumer surplus</td>
<td>233</td>
<td>65.5</td>
<td>566</td>
</tr>
<tr>
<td>Opioid use and fatal overdose risk reduction benefits</td>
<td>291</td>
<td>108</td>
<td>503</td>
</tr>
<tr>
<td>Fatal accident reduction benefits</td>
<td>586</td>
<td>-731</td>
<td>1,840</td>
</tr>
</tbody>
</table>
For the decriminalization alternative, we find mean net benefits of $1.140 billion, with a low estimate of $38.3 million and a high estimate of $2.639 billion. For implementation of medical marijuana without decriminalization, we find mean net benefits of $1.107 billion, with a low of $6.43 million and a high of $2.605 billion. We project that regardless of state policy regarding decriminalization, implementing medical marijuana will have large positive net benefits.

Values for several of our benefit categories are large and can skew the overall results. The impact of medical marijuana on fatal car accidents, for example, has strong impacts on overall net benefits. Because our range of effects on car crashes includes negative values, a small number of trials show net benefits from car accidents being strongly negative. We use a value of statistical life of $9.6 million to estimate these benefits. The value of statistical life represents the tradeoff between risk and compensation for very small changes in the risk of death and allows us
to monetarize certain values, such as the value of one avoided traffic fatality, that would be otherwise difficult to value (Viscusi 2005).

Additionally, many cost and benefit categories depend on the number of medical marijuana users in each of the first five years. In view of the sparse evidence used for arriving at a quantification for state medical marijuana users in each of the first five years [Appx. H], we find a wide range of net benefit estimates. Specifically, projections for consumer surplus derived from our demand schedule vary heavily based on number of yearly users.

LIMITATIONS
Our analysis uses a comprehensive range of available data from states with medical marijuana laws and accounts for the uncertainty of each of our individual predictions. However, our data sources were consistently limited due to the federal status of marijuana as a Schedule 1 substance, which limits the research federal agencies are able to conduct on health effects associated with marijuana and its implementation in states in which it is already legalized. Consequently, available state data on the production and consumption of medical marijuana was inconsistent and reported in dissimilar formats. For example, some states do not track the quantity of marijuana consumed by medical patients, some report an annual quantity sold in weight, and others simply report total sales revenue by month or year. For our market demand prediction and other predictions in the analysis, this variance required that we consider wide ranges of data or simplify our methods to use aggregate information.

Similarly, for some of our predictions, we encountered an underdeveloped literature base, likely because of marijuana legalization’s short history and corresponding lack of state-sponsored research. Thus, for predictions such as the reduction in total car crash fatalities or the price
elasticity of demand for marijuana, our estimates hinge on one or two academic sources. Future analyses should monitor the research base for newly updated estimates from larger data samples.

RECOMMENDATIONS
Our analysis of the costs and benefits associated with medical marijuana legalization and decriminalization resulted in a mean net benefit of $1.140 billion as compared to the $1.107 billion mean net benefit of medical marijuana legalization without decriminalization. To maximize benefits to the state of Wisconsin, we recommend that policymakers implement statewide medical marijuana legalization and decriminalization.

The legalization of medical marijuana with decriminalization is not analogous to legalization of recreational marijuana, which is assumed to have different costs and benefits. Enforcement of marijuana laws surrounding possession of large amounts and cultivation and sale for recreational purposes does not change. We make the following further recommendations to help ensure a smooth implementation of a medical marijuana law:

The Legislative Audit Bureau (LAB), at the request of the Joint Legislative Audit Committee, should conduct a performance evaluation and financial audit of the proposed policy after two years to determine if the program is efficiently and effectively accomplishing its objectives and to identify potential areas for improvement.

The Department of Health Services (DHS), the Department of Workforce Development (DWD), and other related agencies should review best practices and consult regional and national experts in their design of rules and regulations pertaining to the implementation of the proposed medical marijuana law. The Department of Justice (DOJ) should similarly consult best practices with
respect to decriminalization enforcement and intoxicated driving. The department should take particular care to ensure that marijuana policing and decriminalized enforcement practices reflect appropriate best practices and standards.
MEMORANDUM FOR ALL UNITED STATES ATTORNEYS

FROM: Jefferson B. Sessions, Jr.
   Attorney General

SUBJECT: Marijuana Enforcement

In the Controlled Substances Act, Congress has generally prohibited the cultivation, distribution, and possession of marijuana. 21 U.S.C. § 801 et seq. It has established significant penalties for these crimes. 21 U.S.C. § 841 et seq. These activities also may serve as the basis for the prosecution of other crimes, such as those prohibited by the money laundering statutes, the unlicensed money transmitter statute, and the Bank Secrecy Act. 18 U.S.C. §§ 1956-57, 1960; 31 U.S.C. § 5318. These statutes reflect Congress’s determination that marijuana is a dangerous drug and that marijuana activity is a serious crime.

In deciding which marijuana activities to prosecute under these laws with the Department’s finite resources, prosecutors should follow the well-established principles that govern all federal prosecutions. Attorney General Benjamin Civiletti originally set forth these principles in 1980, and they have been refined over time, as reflected in chapter 9-27.000 of the U.S. Attorneys’ Manual. These principles require federal prosecutors deciding which cases to prosecute to weigh all relevant considerations, including federal law enforcement priorities set by the Attorney General, the seriousness of the crime, the deterrent effect of criminal prosecution, and the cumulative impact of particular crimes on the community.

Given the Department’s well-established general principles, previous nationwide guidance specific to marijuana enforcement is unnecessary and is rescinded, effective immediately. This memorandum is intended solely as a guide to the exercise of investigative and prosecutorial discretion in accordance with all applicable laws, regulations, and appropriations. It is not intended to, does not, and may not be relied upon to create any rights, substantive or procedural, enforceable at law by any party in any matter civil or criminal.

APPENDIX B: Abbreviations

AB 75: Assembly Bill 75, the most recently proposed medical marijuana bill in Wisconsin
CBD: Cannabidiol, a chemical compound found in marijuana
CUD: Cannabis use disorders
DAWN: Drug Abuse Warning Network
DHS: Wisconsin Department of Health Services
DOA: Wisconsin Department of Administration
DOC: Wisconsin Department of Corrections
DWD: Wisconsin Department of Workforce Development
ER: Emergency room
FTE: Full-time employee
GPR: General purpose revenue
LFB: Wisconsin Legislative Fiscal Bureau
LRB: Wisconsin Legislative Reference Bureau
MML: Medical marijuana law
MUD: Marijuana use disorder
NASEM: National Academies of Sciences, Engineering, and Medicine
NHTSA: National Highway Traffic Safety Administration
NPV: Net present value
NSDUH: National Survey on Drug Use and Health
SAMHSA: Substance Abuse and Mental Health Services Administration
SCAODA: State Council on Alcohol and Other Drug Abuse
THC: Tetrahydrocannabinol, the main psychoactive chemical compound found in marijuana
VSL: Value of a statistical life
WSIPP: Washington State Institute for Public Policy
APPENDIX C: Exclusion of Fine Enforcement Costs

Under the alternative of medical marijuana legalization with decriminalization, we include the reduction of certain criminal justice system costs in our calculation of net benefits. We explicitly omit an estimation of the impact decriminalization would have on fine revenue and fine enforcement costs for marijuana possession. Our analysis omits these costs for two reasons:

First, we do not expect the incidence of fines or the level of fine revenue to decrease appreciably following decriminalization. Currently, fines can be issued for first-time misdemeanor possession charges. Under decriminalization, jurisdictions could continue to issue municipal fines for simple possession offenses. While it may be reasonable to assume that the fine amount would fall after decriminalization, it is less appropriate to assume that total fine revenue would fall. This distinction is based on an analysis of fine payments in Milwaukee County that found 58 percent of those who received a fine made no payments at all and that only 28 percent of fines were ever paid in full (SCAODA 2016). We therefore assume that although fine amounts may fall after decriminalization, the lower fine amount would lead to higher fine payment rates, offsetting any potential effect.

Second, we presume that the marginal enforcement costs of each fine are very small and therefore negligible. To make this assumption we consider the difference between fixed and variable fine enforcement costs. Fixed enforcement costs are those costs that are independent of number of individual fines levied, whereas variable enforcement costs are those costs that depend on the number of individual fines levied (Polinsky & Shavell 1992). After decriminalization, police forces would still incur large fixed enforcement costs, as fines are issued and enforced for a wide variety of other crimes. In view of the relatively minor incidence of marijuana possession fines compared to all other fine related activity, it is unlikely that the
amount of total fixed fine enforcement costs would change under decriminalization — even if the number of fines issued fell to zero. We also have little reason to believe that the variable fine enforcement costs would change appreciably. Negligible changes to fine enforcement costs are especially likely if police forces continue to issue fines for simple marijuana possession under the decriminalization alternative.
APPENDIX D: Exclusion of Marijuana Use Disorder Costs

National data from the Substance Abuse and Mental Health Services Administration (SAMHSA) shows a 2.7 percent increase of marijuana use from 2002-2016 [Figure 3] (SAMHSA, 2016b). From the NSDUH 2015-2016 findings, in Wisconsin specifically, an estimated 592,000 people ages 12+ used marijuana in the past year. In the past month, an estimated 359,000 people used marijuana, which is 87 percent of total illicit drug use per month. In Wisconsin, adolescents (ages 12-17) accounted for 10 percent of annual users and 9 percent of monthly users (SAMHSA, 2016d). Out of the entire country, Wisconsin accounts for 1.6 percent of annual total marijuana use, and 2 percent of adolescent use (SAMHSA, 2016a). Compared to estimates from 2008-2009 NSDUH data, Wisconsin has seen a 1.53 percent increase in marijuana use and a 0.19 percent increase in adolescent use, in contrast to the national 2.83 percent increase and a 1.08 percent decrease respectively (SAMHSA, 2016c).

![Figure 3: Past Month Marijuana Use among People Aged 12 or Older, by Age Group: Percentages, 2002-2016](image)

* Difference between this estimate and the 2010 estimate is statistically significant at the .05 level.

<table>
<thead>
<tr>
<th>Age</th>
<th>02</th>
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<th>06</th>
<th>07</th>
<th>08</th>
<th>09</th>
<th>10</th>
<th>11</th>
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<tr>
<td>≥12</td>
<td>6.2</td>
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<td>6.3</td>
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<tr>
<td>12-17</td>
<td>7.0</td>
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<td>18-25</td>
<td>16.6</td>
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<td>≥26</td>
<td>4.0</td>
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* Difference between this estimate and the 2010 estimate is statistically significant at the .05 level.
Despite increases in national marijuana use, there was an overall reduction in marijuana use disorder of 0.3 percent from 2002-2016 [Figure 4]. The greatest increase in use was by people aged 18 to 25. The greatest decrease (2 percent) in marijuana use disorder was for people aged 12 to 17, although people 18 to 25 also have seen a minor decrease (1 percent), especially since 2010 (0.7 percent) Overall, in 2016, rates of national marijuana use disorder for people 12 or older was 1.5 percent, 2.3 percent for adolescents, 5.0 percent for those 18-25, and 0.8 percent for people greater than or equal to 26 years of age [Figure 4]. (SAMHSA 2016b). A 2012 study that replicated the National Survey on Drug Use and Health (NSDUH) findings on cannabis use and DSM-IV abuse and dependence found that states with medical legalization had greater numbers of marijuana users as well as greater numbers of those with DSM-IV abuse and dependence of marijuana. However, this study explicitly stated that while there was an overall
increase of abuse and dependence, “there was no increase in odds of abuse or dependence,” thus suggesting the correlation is due to the overall difference in marijuana use (Cerdá et al. 2011). On the other hand, a 2017 review of studies on the effect of medical marijuana legalization on “cannabis use disorders” (CUD) (including the Cerda study) explained that there is variation in the research regarding the effect of medical marijuana legalization on CUD. However, it claims that there is a general, but not statistically significant, trend in increased CUD in medical marijuana legalization states vs. non-medical states (Hasin 2017). Because of the lack of direct statistical correlation regarding marijuana abuse as it relates to legalization of medical marijuana and conflicting broad justifications for research on this topic, we assume no change, positive or negative, in marijuana abuse due to medical legalization.

**Marijuana Use and Legalization**

A 2012 replication study utilizing NSDUH data from 2002-2009 estimates that there is “higher monthly marijuana use in the 16 states that ever passed a [medical marijuana law] (8.68 percent than in states that never passed a law (6.94 percent)” (Harper et al. 2012). These results were comparable to those replicated (Wall et al. 2011). Based on the similarity of results from analyses done, we assume that there is roughly a 1.5 to 2 percent increase in marijuana use from states without medical laws to those with them.

A meta-analysis that surveyed 11 studies regarding medical marijuana laws and adolescent marijuana use found no statistically significant effect of medical laws on adolescent use. The non-significant pooled estimate that was found in this analysis was a -0.003 percent change in adolescent marijuana use from pre- to post-medical marijuana law status, as compared to non-medical marijuana law states (Sarvet et al. 2018). In this study, 7 of the 11 studies showed a
negative change and 4 showed a positive change. Additionally, an analysis of studies found that 16 of 17 difference-in-difference tests indicated no effect from medical marijuana legalization on adolescent use and claimed, “despite differences in methodology, the findings were very consistent” (Hasin 2017). The overall consensus in this research leads us to assume no changes in adolescent use following medical marijuana legalization.
APPENDIX E: Exclusion of Certain Criminal Justice Estimates

In our analysis, we examined criminal justice costs and benefits only under the decriminalization alternative. If medical marijuana was implemented without decriminalization, we assume that the only change in consumer behavior would be for those individuals with medical conditions that entitle them to the medical defense under the new medical marijuana law. We believe that this assumption is reasonable for the reasons outlined below and do not believe that omitting these estimates would affect the overall calculation of net benefits.

A potentially valid concern for policymakers is that there may be considerable overlap between consumers who previously purchased marijuana through black market transactions and consumers who would legally purchase and consume marijuana under the proposed medical marijuana law. If this were the case, then it could provide a signal to policymakers that the program is not being implemented strictly enough; the legalization would simply provide an avenue for black market purchasers to continue their behavior in a legal manner, which is out of line with policy goals. Additionally, this could trigger a need for increased policing due to higher overall rates of marijuana usage statewide. However, data from Minnesota, a state with very similar economic and demographic characteristics as Wisconsin, shows that this concern is unfounded. In Minnesota’s most recent “Medical Cannabis Program Update,” the state evaluated the demographic makeup of those who consumed medical marijuana following the implementation of the state’s medical marijuana law. On the whole, they were:

- Whiter (87.5 percent) on average than the state (81 percent); all people of color groups except for American Indians had a smaller concentration of medical marijuana users than their makeup in the state.
- Older – 51 percent of medical marijuana users were age 50 or above, and 79 percent were age 36 or above. For those treated for intractable pain (66 percent of total users), 56 percent were age 50 or above, and 84 percent were age 36 or above (Minnesota State Department of Health 2018).

This stands in contrast to the typical demographic profile of an illicit marijuana consumer. A national study conducted in 2016 reported marijuana use demographics from data collection spanning 2002 to 2014. Monthly users in this study were:

- Younger. 8.4 percent of all those surveyed reported smoking marijuana in the last month, compared to just 1.3 percent of those age 65 and older, 6.1 percent of those ages 55-64, and 5.9 percent of those ages 45-54.
- Racially equivalent. Besides Hispanic and Asian populations, who used marijuana less on average, most other racial groups used marijuana at very similar rates (Azofeifa 2016).

Additionally, those likely to be *arrested* for marijuana use looked very dissimilar from the population that uses medical marijuana. Research from 2012 examines marijuana possession arrest demographics, and found that those likely to be arrested were:

- Younger. In 2008, nearly 12 percent of male users and 1.4 percent of female users age 15-19 were arrested for marijuana use; less than 2 percent of male users and just 0.3 percent of female users age 50 and above were arrested. For male users, rate of arrest falls by about half between the 15-19 and 20-29 age brackets; for female users, rate of arrest falls by more than half between the 30-49 and 50+ age brackets.
- Black. Just above 1 percent of white adult users were arrested for possession, compared to about 3.5 percent of black adult users (Nguyen & Reuter 2012).
Based on the evidence above, we have ample reason to believe that multiplying the cross section between Wisconsin’s prior, arrested marijuana users and those eligible for medical purchase would result in a negligible cross-section; they are thus excluded from our non-decriminalization analysis.
APPENDIX F: Exclusion of Increased Crime Costs

The association between marijuana use and criminal activity is one reason the federal government and many states remain reluctant to legalize medical marijuana or decriminalize marijuana possession. While there is evidence to suggest a strong correlation between marijuana use and criminal activity, there is little evidence to suggest that this link is causal. Overwhelming research examining the causal relationship between marijuana use and crime find negative or null effects of marijuana use on criminal activity (Bennett et al. 2008; Adda et al. 2014; Braakmann & Jones 2014; Fergusson & Horwood 1997; Green et al. 2010; Markowitz 2005; Norstrom & Rossow 2014; Pacula & Kilmer 2003). Studies that estimate the effects of medical marijuana laws on crime also find no causal increase in crime (Gavrilova et al. 2018; Huber et al. 2016; Morris et al. 2014; Maier et al. 2017; Shepard & Blackley 2016). For example, Gavrilova et al. (2018) found a 12 percent reduction in violent crimes in the three medical marijuana states bordering Mexico and insignificant changes elsewhere following the passage of medical marijuana laws. Likewise, results from Huber et al. (2016) show evidence of a 4 to 12 percent reduction in robberies, larcenies, and burglaries due to medical marijuana legalization. Shepard and Blackley (2016) find no evidence of negative spillover effects from medical marijuana laws on violent or property crime and statistically significant reductions in both violent and property crime. Lastly, Morris et al. (2014) and Meier et al. (2017) both report insignificant reductions in crime rates based on state implementation of legalized and/or decriminalized marijuana.

As none of the above studies find a statistically significant increase in crime, we are comfortable assuming that decriminalizing or legalizing medical marijuana would not increase crime. If anything, it may decrease crime. The benefits of reduced crime, if modeled, would be substantial given the high cost of crime in the United States (McCollister 2010; Miron 2010).
APPENDIX G: Exclusion of Decreased Probation Costs (Decriminalization)

In theory, decriminalizing marijuana should lead to lower rates of probation related to marijuana possession. This avoided criminal justice cost would likely be a net benefit to the state. While we include the reduction in the number of arrests, court proceedings, and jail sentences in our calculation of net benefits, we do not estimate the effects of decreased probation costs. We omit a calculation of this potential benefit for two reasons.

First, marginal supervision costs for simple marijuana possession offenses are likely to be extremely low and substantially below the average cost of supervision. According to the fiscal estimates prepared by the Legislative Fiscal Bureau, the Department of Corrections estimates that the average cost of supervision is roughly $3,000 per probationer (Jokisch 2017). This estimate is an average across all offenders, including those that may require intensive community supervision. It is very likely that the average cost of supervising a marijuana possession offender, especially a misdomant, would be substantially lower than the average cost of supervision for all offenders.

Second, we do not have evidence to suggest that the number of avoided supervisions would be significant, both in terms of the number of probations avoided and the length of probationary terms prevented. In a June 2016 report issued by the State of Wisconsin State Council on Alcohol and Other Drug Abuse (SCAODA) the authors found that 4,394 individuals in Wisconsin were charged with marijuana possession in 2013 (possession the most serious offense). Of those charged, only 22 percent of those were sentenced to jail. Of those sentenced to jail, roughly 60 percent (589 people) actually served any jail time. According to the SCAODA report, the average jail sentence for all individuals sentenced to jail was 71 days, regardless of if
jail time was actually served. The report also noted that individuals with little or no previous criminal history were rarely sentenced to jail time for possession offenses (SCAODA 2016). From these data, we estimate that only those individuals charged with a felony conviction would require supervision. In our estimation, decriminalization would not substantially alter the number of individuals with felony convictions. These data also suggests that the average length of supervision would be very low and likely not exceed the average sentenced jail term.

Taken together, the low level of supervision costs combined with the relatively low level of individuals under supervision would lead to a negligible impact on net benefits. We are therefore comfortable excluding this estimate from our calculation and believe that the moderate benefits from other avoided criminal justice costs, including arrest and court costs, more accurately reflect the true change in net benefits arising from decriminalization.
APPENDIX H: Calculation of Percentage of State Population on Medical Marijuana Registry

To predict the costs and benefits of legalizing medical marijuana in Wisconsin, we first estimate the number of individuals who would use medical marijuana under the proposed program. Because there is no federal standard for reporting and publishing these data, we rely on state-level data to project what may happen with implementation in Wisconsin. To estimate the number of people who would use and consume medical marijuana in Wisconsin under our policy alternatives, we use aggregated data from other states to estimate uptake. To control for differences in state data collection practices and the considerable variation in medical marijuana laws, we only use data from states with medical marijuana laws that are similar to the proposed alternative.

Information Used

States. In the United States, 33 states have legalized medical marijuana. Excluding states where recreational marijuana has also been legalized, there are 22 states where only medical marijuana has been legalized. We believe that registry data from these 22 states will realistically predict expected medical marijuana use in Wisconsin under our policy alternatives because they are not affected by recreational users. We expect that the 11 states that allow recreational marijuana use would have a lower percentage of medical marijuana users than the 22 states that only allow medical marijuana because of the burden associated with using medical marijuana. Residents who would otherwise use medical marijuana in states with recreational marijuana laws would likely avoid this burden by purchasing recreational marijuana.
To obtain a point estimate of the percentage of the state population that would apply for inclusion in the medical marijuana registry, we initially attempted to find the total number of registered users in all 22 sample states and then divide that total by the total population of those 22 states. Of the 22 states in our initial sample, only 15 had published registry data in 2017. We also included Michigan in our sample, which, despite voting to fully legalize recreational marijuana in November 2018, had reliable registry data on the number of people included in the medical marijuana program.

Values. To estimate a five-year percentage of the total Wisconsin population likely to seek inclusion in the medical marijuana registry, we further refined the pool of 16 states. States in this group were at different stages of implementation. Hawaii, for example, implemented their current law in 2000, whereas Arkansas and Florida both implemented theirs in 2016. Some states publish only their most recent registry volume which prevented us from examining trends in those states overtime. Trends in all states indicate that the population of registered patients continues to increase after the first five years. Twelve of the 16 states in our sample implemented their laws prior to 2013, which meant that using their most recent percentage estimate would overestimate the registry population.

Differences in take-up rates may be due to differences in the medical conditions for which states allow medical marijuana use. To account for these potential differences, we sought data from states with medical marijuana laws with medical eligibility requirements that were as similar to AB 75 as possible:

1 These states include Minnesota, Illinois, New York, New Hampshire, Rhode Island, Connecticut, Delaware, Maryland, Florida, Montana, Arizona, New Mexico, Arkansas, New Jersey, and Hawaii.
• Cancer
• Glaucoma
• Acquired immunodeficiency syndrome
• Positive test for HIV
• Antigen, non-antigenic products, or antibody to HIV
• Crohn’s disease
• Hepatitis C
• Alzheimer’s disease
• Amyotrophic lateral sclerosis (ALS)
• Nail patella syndrome
• Ehlers-Danlos Syndrome
• Post-Traumatic Stress Disorder (PTSD)
• Chronic or debilitating disease or medical condition
• Treatment of a chronic or debilitating disease or medical condition that causes:
  ○ Cachexia
  ○ Severe pain
  ○ Severe nausea
  ○ Seizures (including epilepsy)
  ○ Severe and persistent muscle spasms (including multiple sclerosis)
• Any other medical condition or treatment for a medical condition designated by the Department of Health Services
Relative to the other states in our sample, AB 75 includes a broad list of qualifying medical conditions. It includes, for example, Post-Traumatic Stress Disorder (PTSD), which affects nearly seven percent of all people at some point in their lives and affected 3.6 percent of U.S. adults last year. Only seven other states we analyzed included PTSD as an eligible condition.\(^2\)

Additionally, the way that AB 75 specifies “severe pain” is distinct from other sources, and other language included ("a chronic or debilitating disease or medical condition," “severe and persistent muscle spasms,” etc.) suggest that chronic pain is also a qualifying condition.

**Data Sources**

Based on the inclusion criteria outlined above, we only include states with similar legal constructions to AB 75 (especially with respect to medical eligibility) and high-quality longitudinal data over all or some of the first five years of implementation. The following states were therefore excluded from our initial sample of states:

- **Minnesota.** We exclude Minnesota from our sample because Minnesota’s medical marijuana law does not include smokable marijuana (flower). Flower marijuana is a common delivery method for marijuana consumption and we believe that by excluding flower and flower byproducts, Minnesota's law likely understates product demand, leading to lower implementation and registry numbers that we might expect in Wisconsin under our proposal.

• Michigan, Rhode Island, Connecticut, Maryland, Montana, Arkansas, Hawaii, and New York. We exclude these states because registry data were not available for any of the first five years of implementation.

• Illinois and New Hampshire. We exclude these states because their medical marijuana laws are significantly more restrictive than AB 75. Illinois’ medical marijuana law was recently expanded to include “serious diseases causing chronic pain and debilitating conditions,” but registry does not yet include these users.³ New Hampshire’s medical marijuana law makes no mention of pain or PTSD, and limits eligibility for severe pain to individuals who can prove that previously prescribed medication or surgical measures were ineffective or produced serious side effects.⁴

After excluding these states, our sample includes the following five states:

• Florida. We include registry data from the first full year of implementation in our sample.

• Arizona, New Mexico, New Jersey, and Delaware. We include registry data from the first five full years of implementation in our sample.

Methodology

For each of the five states in our final sample, we find the number of registered medical users in that state for years one through five (just year one in Florida). We then used U.S. Census Bureau data to find a mid-year population estimate for each state. By dividing the registry number by population, we find the percentage of the state population on the medical registry.

³ H.B. 0001, Sess. of 2013. (Ill. 2014)
⁴ H.B. 573, Sess. of 2013 (N.H. 2013)
Table 2: Percent Population on Registry Projections in Years 1-5

<table>
<thead>
<tr>
<th>State/Value</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Florida</td>
<td>0.20</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>New Jersey</td>
<td>0.02</td>
<td>0.04</td>
<td>0.08</td>
<td>0.14</td>
<td>0.19</td>
</tr>
<tr>
<td>Delaware</td>
<td>0.01</td>
<td>0.01</td>
<td>0.06</td>
<td>0.18</td>
<td>0.35</td>
</tr>
<tr>
<td>Arizona</td>
<td>0.70</td>
<td>0.98</td>
<td>1.29</td>
<td>1.66</td>
<td>2.18</td>
</tr>
<tr>
<td>New Mexico</td>
<td>0.39</td>
<td>0.51</td>
<td>0.60</td>
<td>0.94</td>
<td>1.39</td>
</tr>
<tr>
<td>Low</td>
<td>0.01</td>
<td>0.01</td>
<td>0.06</td>
<td>0.14</td>
<td>0.19</td>
</tr>
<tr>
<td>High</td>
<td>0.70</td>
<td>0.98</td>
<td>1.29</td>
<td>1.66</td>
<td>2.18</td>
</tr>
<tr>
<td>Mean/Point Estimate</td>
<td>0.26</td>
<td>0.39</td>
<td>0.51</td>
<td>0.73</td>
<td>1.03</td>
</tr>
<tr>
<td>Number of states</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

With this knowledge, we use the lowest percentage in each year as our low value, the highest percentage as our high value, and the average over the four/five states as our point estimate.

Limitations

Using a range as wide as 2 percent in our fifth year yields a vast range of results. Two percent of a population of six million represents a difference of 120,000 people. Much of the range in our Monte Carlo simulation can be attributed to the variable nature of our projected registry population.
APPENDIX I: Calculation of Demand Schedule

To predict consumer surplus in the market under our two alternatives we estimate 1) the number of medical marijuana users in the emerging Wisconsin market; 2) quantity sold to each patient per month (in grams); 3) the price of medical marijuana (per gram); 4) the price elasticity of demand for medical marijuana; and 5) the assumed functional form of the demand curve.

Number of medical marijuana users in the emerging Wisconsin market
See Appendix H for a full description of the methodology for estimating the number of patients who would join the Wisconsin medical marijuana registry and market. As concluded there, we predict a full-implementation midpoint estimate of 1.06 percent of the state population, with a range from 0.19 percent to 2.18 percent, and 5 years to achieve full take-up rates.

Quantity sold per patient per month (in grams of “flower”)
To predict aggregate demand during a certain time period, based off the number of patients who are predicted to join the registry, we estimate a quantity sold per patient using the experiences of other jurisdictions. While most states with medical marijuana regularly report the number of patients on their registries, fewer track and report the actual quantity of sales observed.

Canada and New Mexico report a quarterly quantity of cannabis sold (in weight) alongside their counts of patients on the registry. Canada data were available for 2014-2018, and New Mexico data were available for 2017. By dividing the total cannabis sold by the number of patients on the registry, we yielded an average quantity sold to each consumer per quarter. We divided that figure by three months per quarter to obtain a monthly average for quantity consumed (in grams). Similarly, Arizona and Illinois provide monthly reports of quantity of cannabis sold (in weight) alongside patient registry counts. Arizona data were available for 2014-2018 and Illinois data...
were available for 2016-2018. By dividing the monthly sales quantity (converted to grams) by the number of patients on the registry, we yield a comparable monthly average of quantity consumed (in grams), thus giving us four jurisdictions to compare for our estimate.

This estimate is a proximate measure of monthly consumption. Not every patient on a medical marijuana registry buys marijuana consistently, or in consistent quantities. Thus, it is likely that our monthly consumption estimate is conservatively biased – by dividing by a number of patients that is almost certainly higher than those who actually purchase marijuana in a given month, we are likely to see a lower average quantity sold per patient.

![Figure 5: Quantity Sold per Patient per Month (grams) in Other Jurisdictions](image)

As seen in Figure 5, a lack of consistent data and data from other states with medical marijuana laws yields a wide range of monthly consumption values, from a minimum of 6.82 grams per patient per month in 2018 Quarter 1 in Canada to a maximum of 24.44 grams per patient per
month in 2018 Quarter 3 in Arizona. We observed a mean monthly consumption value of 15.95 grams per patient per month.

Our estimates of the monthly consumption amount per patient is a point estimate of 15.95 grams with a possible range from 6.82 grams to 24.44 grams. Although data are somewhat limited and usage patterns may vary based on state population characteristics and the conditions treated, we observe that most average quantities fall nearer to the midpoint estimate, so we assign a normal distribution to the values within this range (where values near the point estimate are more common than those near the edge of the range).

The Price of Medical Marijuana (per gram)
The price of medical marijuana is likely to vary widely based on quality, even within the state. In one nationwide study of over 23,000 transactions, high-quality marijuana in states with medical marijuana sold for $12.56 per gram; medium-quality sold for $9.71 per gram, and low-quality sold for $6.76 per gram (Davis et al. 2016). Marijuana was also found to be cheaper in the Pacific and Mountain regions than in the Midwest, East, and South. One review of federally-licensed medical providers in Canada found a market average of $8.40 per gram with a maximum of $15 per gram and minimum of $5 per gram (Martin 2016).

In order to more fully assess the current levels of marijuana prices throughout the United States, we use data from New Mexico, Illinois, and Canada, which were available from 2015-2017, 2016-2018, and 2015-2017, respectively. Average quarterly price was reported in New Mexico, and average yearly price was reported in Canada. To obtain an average price of flower in Illinois, we divided the total monthly sales of flower ($) by the total monthly quantity sold of flower.
(grams). As seen in Figure 6, a range of prices is observed, from a low of $6.21 per gram in Canada in 2017 to a high of $12.34 per gram in Illinois in 2016, with a mean of $10.43 per gram.

![Figure 6: Observed Price per Gram ($) in Other Jurisdictions](image)

The lower prices in Canada might be explained by lower quality, but more likely are due to a more mature supply market in the country as compared to the states here. Furthermore, the relatively high values observed in New Mexico and Illinois intuitively match the range from Davis, Geisler, and Nichols, because they fall between medium- and high-quality averages. This observation matches other research findings on medical marijuana states with retail dispensaries, which showed that the presence of medical marijuana leads to a slight increase in marijuana potency through a greater market share occupied by high-quality flower (Sevigny et al. 2014). And while Martin’s Canadian market research indicates a maximum gram price of $15, we will cap our estimated range at Illinois’ observed maximum of $12.34. This is because we are estimating an average price for all types of marijuana sold, not just the highest quality, and
because recreational legalization in other states has led to highly competitive markets and
dramatic price decreases (Smart et al. 2017).

Our estimates of the average price per gram of medical marijuana (flower) uses a point estimate
of $10.43 per gram with a possible range from $6.21 per gram to $12.34 per gram. Although data
are somewhat limited, and price may vary based on supply markets and state population
characteristics, we observe that most average quantities fall nearer to the midpoint estimate, so
we assign an asymmetric triangular probability distribution to the values within this range (where
values near the point estimate are more likely than those near the edge of the range).

Price Elasticity of Demand for Medical Marijuana
Calculating price elasticities of demand for the jurisdictions we used previously is beyond the
scope of this project and the data reported by the various agencies. Numerous factors may impact
the price of marijuana in each state and country beyond just the quantity sold, but we did not
have the capability to regress the consumption data on these other factors. Therefore, we utilized
a simpler range of price elasticities as calculated by Davis et al. (2016), from -0.67 to -0.79, with
a midpoint estimate of -0.73.

Assumed Functional Form of the Demand Curve
Marijuana price, as noted by Davis et al. (2016), is highly variable due to quality and other
factors. Due to this and for simplicity’s sake, we assume that price elasticity is non-constant
along the demand curve and that the demand curve itself follows a linear functional form.
**Consumer Surplus Midpoint Estimate for Flower**

The yearly consumer surplus depends on several parameters that will be allowed to vary within the ranges stated previously. These include the following:

**Table 3: Quantifications for Demand Schedule Calculation**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Variable</th>
<th>Point Estimate</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Distribution within Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Population</td>
<td>pop</td>
<td>5,856,519</td>
<td>5,816,231</td>
<td>5,914,808</td>
<td>Normal</td>
</tr>
<tr>
<td>Population growth rate</td>
<td>r-pop</td>
<td>.6% (.006)</td>
<td>.4%</td>
<td>.8%</td>
<td>Normal</td>
</tr>
<tr>
<td>Percentage of Population on the Registry</td>
<td>popreg5</td>
<td>1.03%</td>
<td>0.19%</td>
<td>2.18%</td>
<td>Asymmetric triangular</td>
</tr>
<tr>
<td>Price per gram, flower ($)</td>
<td>p</td>
<td>$10.43</td>
<td>$6.21</td>
<td>$12.34</td>
<td>Asymmetric triangular</td>
</tr>
<tr>
<td>Monthly quantity sold per patient (g)</td>
<td>qmon</td>
<td>15.95</td>
<td>6.82</td>
<td>24.44</td>
<td>Normal</td>
</tr>
<tr>
<td>Annual quantity sold per patient (g)</td>
<td>qyear-</td>
<td>191.4</td>
<td>81.84</td>
<td>293.28</td>
<td>Normal</td>
</tr>
<tr>
<td>Price elasticity of demand at market equilibrium</td>
<td>ed</td>
<td>-0.73</td>
<td>-0.67</td>
<td>-0.79</td>
<td>Uniform</td>
</tr>
</tbody>
</table>

Our analysis calculates a consumer surplus for each year of implementation based on these parameters. The percentage of the population on the registry increases with each year until full implementation in Year 5. Below, we present an example of the methodology for calculating consumer surplus in the medical marijuana market in Year 5, using the midpoint estimate for
each stated parameter. In the full analysis, this technique is utilized for each year and repeated using Monte Carlo analysis to examine the sensitivity of our parameter distributions.

**Year 5 Medical Benefits Midpoint Example**

To construct the demand curve in Year 5, we first estimate the aggregate quantity demanded in the market for that year \(Q_{agg}\).

\[
Q_{agg} = \text{Pop}_{reg5} \times (\text{Pop} \times (1 + r_{\text{Pop}})^5) \times Q_{\text{year}}
\]

Midpoint Example: \(Q_{agg} = 0.0103 \times (5,865,519 \times (1 + 0.006)^5) \times 191.4\)

\[
Q_{agg} = 11,914,491.39 \text{ grams in Year 5}
\]

\[
Q_{agg} = 11.914 \text{ million grams}
\]

Then, we estimate the slope of the demand curve, which is assumed to be linear, by using the predicted equilibrium price and quantity alongside the equilibrium price elasticity of demand provided by the literature.

\[
\text{Slope} = E_D \times (\text{Initial } Q_{agg} / \text{Initial } P)
\]

Midpoint Example: Slope = \(-0.73 \times (11.914 / 10.43)\)

\[
\text{Slope} = -0.8339001
\]

This slope is inserted into a standard form demand curve equation so that we can find the intercept term of the demand curve.

\[
Q_D = Q_{\text{intercept}} - \text{slope} \times (P)
\]
Midpoint example: $11.914 = Q_{\text{intercept}} - 0.8339001 (10.43)$

$Q_{\text{intercept}} = 20.537$ million grams

Using this intercept term, we can conclude the demand curve equation is as follows:

$$Q_{D} = Q_{\text{intercept}} - \text{slope} \cdot (P)$$

Midpoint example: $Q_{D} = 20.537 - 0.8339001 \cdot (P)$

With the full demand curve equation, we can calculate the choke price, or the price intercept term – that is, the price at which annual quantity demanded = 0.

$$Q_{D} = Q_{\text{intercept}} - \text{slope} \cdot (P)$$

$$0 = Q_{\text{intercept}} - \text{slope} \cdot (P_{\text{choke}})$$

Midpoint example: $0 = 20.537 - 0.8339001 \cdot (P_{\text{choke}})$

$$P_{\text{choke}} = 24.63$$

With a choke price and the estimated price and quantity demanded at market equilibrium, we are able to calculate the consumer surplus of the market, represented by the triangle area beneath the demand curve but above the equilibrium price (Table 3). The equation below finds the area of that triangle, then multiplies by one million to account for the quantity axis being stated in millions of grams.

$$\text{Consumer Surplus} = \frac{(P_{\text{choke}} - P_{\text{equilibrium}}) \cdot Q_{\text{agg}}}{2} \cdot 1,000,000$$

Midpoint example: Consumer surplus = $\frac{(24.63 - 10.43) \cdot 11.914}{2} \cdot 1,000,000$
Consumer surplus = $84,589,000 in Year 5 with all parameters estimated at their midpoints

Figure 7: Demand Schedule and Consumer Surplus for Cannabis Flower, Year 5 Midpoint Estimate

This methodology was coded into Stata for each year, including Years 1-4 with partial registry take-up. Benefits from medical demand are aggregated for all years and reported as Total Medical Benefits from Flower.

Accounting for Concentrates and Infusions

The above methodology calculated only the consumer surplus for the predicted market equilibrium of smokable cannabis, or flower – and did not include patients’ potential purchases on other types of marijuana products. As described earlier, data availability issues and the lack of a consistent relationship between quantity, price, and potency make the prior method inapplicable to this potential market. Therefore, we consider the potential market for
concentrates and infusions as an add-on to the existing consumer surplus observed in the predicted market for flower.

Illinois was the only state in our sample to report total sales (in dollars) of both flower and concentrates/infusions. We estimate the ‘extra’ benefits of concentrates and infusions by calculating the proportion of total marijuana sales in Illinois that were due to concentrates and infusions in each month. The proportion of total monthly sales coming from concentrates/infusions had an observed minimum of 39.4 percent, maximum of 51.7 percent, and a mean value of 46.2 percent. We define the “proportion of the market sales in concentrates and edibles” as a parameter with a point estimate of 46.2 percent and uniform probability within the range of 39.4 percent and 51.7 percent.

Such a parameter allows for a simplified, after-the-fact adjustment to the consumer surplus observed in the predicted market for flower to estimate the benefits of the missing concentrates market that we could not estimate directly. The logic is as follows: whatever the consumer surplus is from the flower market, multiply those benefits by a multiplier corresponding to the estimated share of the market going to flower rather than concentrates.

\[
\text{Consumer Surplus}_{\text{Total}} = \frac{1}{(1 - \% \text{ of market}_{\text{concentrates/infusions}})} \times \text{Consumer Surplus}_{\text{Flower}}
\]

Midpoint example: \(\text{Consumer Surplus}_{\text{Total}} = \frac{1}{(1 - .4615)} \times 84,589,000\)

\[
\text{Consumer Surplus}_{\text{Total}} = 157,082,636.95 \text{ in Year 5}
\]
APPENDIX J: Calculation of Benefits from Predicted Reduction in Opioid Addiction

Marijuana as a Potential Substitute for Opioids

While there is limited clinical trial evidence for marijuana as a treatment for any disease, there is compelling medical evidence for marijuana as a treatment for chronic pain. In a literature review, Baron (2015) found that “cannabis may have a therapeutic role” in a number of headache-type pains, although evidence tended to be “case based, anecdotal, or laboratory-based.” Hill (2015) and Jensen et al. (2015) support Baron’s conclusions, as well as finding a positive effect of marijuana on other types of chronic pain. Small randomized control trials with 55 or fewer participants provide limited evidence for marijuana as a treatment for chronic non-cancer pain (Deshpande 2015). Another study found potential positive synergistic effects of combined marijuana and opioid therapy for pain (Bushlin et al. 2010). Perhaps most compelling, Bachhuber et al. conducted a time series analysis of medical cannabis laws and state-level death certificate data from 1999-2010 and found that states with medical marijuana laws had a 24.8 percent lower mean annual overdose mortality rate compared to states without such laws (2014).

These findings are supported by survey data. In a 2014 survey, 30 percent of Canadian medical marijuana patients self-reported using cannabis as a substitute for pharmaceutical opioids (Lucas & Walsh 2017). A survey of Michigan residents found a 64 percent decrease in the number of medical marijuana patients using opioids before cannabis initiation and the number of medical marijuana patients using opioids after cannabis initiation (Boehnke et al. 2016).
Opioid Use in Wisconsin
The number of deaths from opioid-related overdoses continues to increase in Wisconsin, reaching a statewide high of 833 deaths in 2017, even though the number of opioid prescriptions has decreased by more than 20 percent. The rate of opioid use disorder has more than tripled since 2005, although it has decreased in the past year. DHS estimates that 19,775 people in the state currently suffer from opioid use disorder. DHS and state government consider current rates of opioid abuse to be an epidemic and a public health crisis.

Using studies that show rates of addiction between 8 and 12 percent of people prescribed opioids for chronic pain (NIH), we estimate that 10 percent of prescription opioid users will develop addictions. Using DHS statewide data from 2016, we estimate that 4.2 percent of people addicted to opioids will suffer a fatal overdose (833/19775 = .042).

Minnesota’s Intractable Pain Study
Minnesota expanded the conditions for which medical marijuana is permitted to include intractable pain on August 1, 2016. Following the inclusion of intractable pain, Minnesota performed a study of medical marijuana patient responses to the use of marijuana for this condition. Part of the study included a survey of providers evaluating their patients’ use of opioid and other prescription medication. This study found the following results:

Table 4: Minnesota Intractable Pain Study – Intractable Pain

<table>
<thead>
<tr>
<th>Patients with Intractable Pain (n=654)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients with a pain treatment therapy</td>
</tr>
<tr>
<td>Patients without pain treatment therapy</td>
</tr>
<tr>
<td>Patients known to be taking opioids at baseline</td>
</tr>
</tbody>
</table>
Table 5: Minnesota Intractable Pain Study – Opioids at Baseline

<table>
<thead>
<tr>
<th>Patients Taking Opioids at Baseline (n=353)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did not change opioid use</td>
</tr>
<tr>
<td>Reduced opioid use by less than 50%</td>
</tr>
<tr>
<td>Reduced opioid use by more than 50%</td>
</tr>
</tbody>
</table>

Source: Intractable Pain Patients in the Minnesota Medical Cannabis Program: Experience of Enrollees During the First Five Months

Percentages of People Who Seek Marijuana for Pain Treatment

As shown in the table below, the percentage of people who seek marijuana for pain treatment varies by state. Based on the ranges below, we estimate that 75 percent of people who seek medical marijuana will seek it for pain treatment.

Table 6: Percentage of Medical Marijuana Patients with Pain Diagnosis

<table>
<thead>
<tr>
<th>State and Pain Condition</th>
<th>Percentage of MM Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minnesota (Intractable Pain)</td>
<td>66(^5)</td>
</tr>
<tr>
<td>Michigan (Severe and Chronic Pain)</td>
<td>80(^6)</td>
</tr>
<tr>
<td>New Mexico (Chronic Pain)</td>
<td>33 (65 if PTSD is removed from patient count)(^7)</td>
</tr>
<tr>
<td>Arizona (Chronic Pain)</td>
<td>86.55(^8)</td>
</tr>
</tbody>
</table>

While there is consistent evidence that marijuana and opioids likely have a substitutionary effect, it is difficult to confidently project the magnitude of those effects using statistics from published surveys due to likely confounding factors and the overall ecological nature of most studies.

---

\(^5\) Minnesota Medical Cannabis Program Update July 2018: http://www.health.state.mn.us/topics/cannabis/about/update0718.pdf
\(^7\) New Mexico Medical Cannabis Program Patient Statistics December 2017 https://nmhealth.org/publication/view/report/4174/
We developed the following model to predict the effects of medical marijuana on opioid addiction and mortality based on estimates of the number of patients who seek marijuana for pain treatment and the substitutionary effects of marijuana for opioids experienced by Minnesota medicinal marijuana patients, based on data from Minnesota’s report on the early experience of medical marijuana patients.

In the following diagram, the numbers in blue represent an estimate of what percentage of patients will seek medicinal marijuana for pain treatment compared to seeking medicinal marijuana for other treatments. The numbers in red are from the Minnesota study.

Figure 8: Opioid Overdose and Addiction Reduction Flow

Based on the mapping above, we estimate the percentages of medical marijuana patients in the following categories:
### Table 7: Medical Marijuana Patient Percentages – Opioid Reduction

<table>
<thead>
<tr>
<th>Categories</th>
<th>Estimated Percentage of Overall Medical Marijuana Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>MM Patients Seeking Treatment for Pain</td>
<td>75</td>
</tr>
<tr>
<td>MM Patients in Wisconsin with Chronic Pain Currently Using Opioids</td>
<td></td>
</tr>
<tr>
<td>Pain * Current Pain Medication * Opioid Pain Medication</td>
<td>40.5</td>
</tr>
<tr>
<td>(.75 * .9 * .6)</td>
<td></td>
</tr>
<tr>
<td>MM Patients Projected to Experience No Change in Opioid Use</td>
<td></td>
</tr>
<tr>
<td>Pain * Current Pain Medication * Opioid Pain Medication * No Change</td>
<td>15.0</td>
</tr>
<tr>
<td>(.75 * .9 * .6 * .37)</td>
<td></td>
</tr>
<tr>
<td>MM Patients Projected to Reduce Their Current Use of Opioids by Less than 50%</td>
<td>10.9</td>
</tr>
<tr>
<td>Pain * Current Pain Medication * Opioid Pain Medication</td>
<td></td>
</tr>
<tr>
<td>(.75 * .9 * .6 * .27)</td>
<td></td>
</tr>
<tr>
<td>MM Patients Projected to Reduce Their Current Use of Opioids by More than 50%</td>
<td>14.6</td>
</tr>
<tr>
<td>(.75 * .9 * .6 * .36)</td>
<td></td>
</tr>
</tbody>
</table>

Patients who use opioids are at risk for addiction and subsequent overdose. Data based on opioid-related overdoses in North Carolina has found an increase in death rates per 10,000 person-years as doses of opioid medications increase.
Based on this overall trend, we estimate that MM patients who reduce their use of opioids at all reduce their risk of addiction by 50 percent. Patients who reduce their use of opioids by 50 percent or more, potentially even eliminating their use of opioids, reduce their use of opioids dramatically and represent a marked departure from problematic use patterns. For these patients, we estimate an 80 percent reduction in risk. This estimate is consistent with the pattern of fatal overdose rates demonstrated by Dasgupta et al., where fatal overdose rates increased from 3.2 per 10,000 person years in patients who consume between 60 to 79.9 mg/day to 14.4 per 10,000 person years in patients who consume between 120 to 139.9 mg/day. To account for uncertainty, in our sensitivity analysis we use a range of 40 to 60 percent reduced risk of addiction for patients who reduce their use of opioids by less than 50 percent, and a range of 70 to 90 percent reduced risk of addiction for patients who reduce their use of opioids by more than 50 percent.

**Figure 9: Incidence Rates and Ratios for Overdose Deaths Involving Opioid Analgesics**
Table 8: Risk Reduction Calculations I

<table>
<thead>
<tr>
<th>Reduction in Opioid Use</th>
<th>Reduced Risk (Initial Estimate)</th>
<th>Reduced Risk (Range for Sensitivity Analysis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 50%</td>
<td>.5</td>
<td>.4-.6</td>
</tr>
<tr>
<td>More than 50%</td>
<td>.8</td>
<td>.7-.9</td>
</tr>
</tbody>
</table>

Using information from NIH, we estimate that 10 percent of prescription opioid chronic pain patients will develop addictions. Using statewide data from 2016, we estimate that 4.2 percent of people addicted to opioids will suffer a fatal overdose (833/19775 = .042).

Table 9: Risk Reduction Calculations II

<table>
<thead>
<tr>
<th>Risk for Opioid Users</th>
<th>Risk Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opioid Addiction</td>
<td>.1</td>
</tr>
<tr>
<td>Opioid Overdose for Addicted Users</td>
<td>.042</td>
</tr>
</tbody>
</table>

With the statistics and estimates outlined above, we can estimate the following equations to estimate the reductions in opioid addiction:

\[
\text{Reduced Opioid Addictions} = \alpha(uz + tv)
\]

Where:

- \( \alpha \) = Estimated Number of MM Patients
- \( u \) = the estimated percentage of MM patients who use opioids and will reduce their use by < 50% (.109)
- \( z \) = the reduction in risk for patients who use opioids and reduce their risk by < 50% (estimated at .1 * .5 = .05)
- \( t \) = the estimated percentage of MM patients who use opioids and will reduce their use by > 50% (.146)
- \( v \) = the reduction in risk for patients who use opioids and reduce their risk by > 50% (estimated at .1*.8=.08)

Using our midpoint estimates, we estimate reduced opioid addictions due to MM using the equation:

\[
\text{Reduced Opioid Addictions} = \alpha[ (.109 * .05) + (.146 * .08)]
\]
Which reduces to:

Reduced opioid addictions = \(0.0171\, \alpha\)

Using a similar equation, we estimate the number of reduced opioid overdoses as follows:

Reduced opioid overdoses = \(\alpha (ua + tb)\)

Where:
- \(\alpha\) = Estimated Number of MM Patients
- \(u\) = the estimated percentage of MM patients who use opioids and will reduce their use by < 50\% (0.109)
- \(a\) = the reduction in risk for patients who use opioids and reduce their risk by < 50\% (estimated at \(0.042 \times 0.05 = 0.0021\))
- \(t\) = the estimated percentage of MM patients who use opioids and will reduce their use by > 50\% (0.146)
- \(b\) = the reduction in risk for patients who use opioids and reduce their risk by > 50\% (estimated at \(0.042 \times 0.08 = 0.0033\))

Using our midpoint estimates, we estimate reduced opioid overdoses due to MM use can be represented by the equation:

\[\text{Reduced Opioid Overdoses} = \alpha [ (0.109 \times 0.0021) + (0.146 \times 0.0033)]\]

Which reduces to:

\[\text{Reduced opioid overdoses} = 0.000717\, \alpha\]

**Estimating a Shadow Price for Opioid Addiction and Fatalities**

Florence et al. (2016) from the National Center for Injury Prevention and Control and from the Centers for Disease Control and Prevention developed a shadow price for opioid addiction and fatalities. These shadow prices consider health care costs, substance abuse treatment costs, criminal justice costs, and lost productivity costs (Florence et al. 2016). Based on their work, we can summarize the shadow prices for prescription opioid overdose, abuse, and dependence:
Table 10: Cost per Fatality and Addiction in Opioid Usage

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Fatal Costs</td>
<td>56,990 M</td>
<td>29,452 per person</td>
<td>32,286 per person per year</td>
</tr>
<tr>
<td>Fatal Costs</td>
<td>21,513 M</td>
<td>1.325 M per person</td>
<td>1,452,499 per person</td>
</tr>
</tbody>
</table>

These numbers are based on an estimate of 1.935 million people with opioid use disorder and 16,235 deaths due to opioids in 2013. This study did not take into account quality-adjusted life year reduction, or pain and suffering of family members. As a result, the cost per person is substantially less than might be expected with a typical value of a statistical life (VSL) calculation. We use the shadow price estimated by Florence et al. (2016) to avoid double-counting, and consider the value persons suffering from chronic pain place on avoiding opioid-related addiction and death as represented in the demand schedule for medical marijuana.

Equation for Benefits from Reduced Opioid Addiction and Overdoses

Combining all of the information above, we estimate the following equation for benefits related to reduced opioid addiction and overdoses:

\[ \text{Benefits} = 0.0233\alpha\beta + 0.000979\alpha\Phi \]

Where:
- \( \alpha = \) MM patients
- \( B = \) Shadow price for addiction ($32,286)
- \( \Phi = \) Shadow price for overdose ($1,452,499)

Population Size, 2018
The U.S. Census Bureau’s most recent population estimate uses 2010 Census data to project a July 1, 2017 Wisconsin population of 5,795,483 (U.S. Census Bureau 2017). Because Census Bureau data projections are not available in Wisconsin for any date within the last year, we choose not to rely on their most recent July 2017 projection. The Department of Administration (DOA) projected a January 1, 2018 estimate of 5,816,231. Another estimate made by the DOA in 2014 projects a population of 5,914,808 in 2018 with no specific date (Demographic Services Center 2014). We use the first DOA estimate as a low cutoff and the 2014 DOA estimate as a high cutoff, with the average as our point estimate, to calculate Wisconsin’s 2018 population.

Population Growth, 2018-2023
We accumulated a number of sources in order to project average yearly population growth for the five-year time horizon we use in this analysis. The University of Wisconsin, Madison’s Applied Population Lab operates the “GetFacts” website, which provides numerous useful demographic facts on the state. They projected yearly state population growth of 0.4 percent in 2015 and 2016 and 0.1 percent in 2017 (GetFacts 2017). Using a 2020 projection from Get Facts of 6,005,080, however, average yearly growth rate from 2017 to 2020 would be about 0.9 percent (GetFacts 2017). DOA’s 2014 estimate projected yearly population for every year from 2010 to 2025, and found a range of 0.65 to 0.76 percent in each year from 2015 to 2023. The U.S. Census Bureau estimated yearly growth rates of 0.2 percent in 2015 and 2016 and 0.4 percent in 2017 (Census Bureau 2017). Therefore, we assume a low yearly average growth rate of 0.4 percent and a high of 0.8 percent, with 0.6 percent as our point estimate.
# APPENDIX L: Calculation of Administrative Costs and Benefits

## Table 11: Administrative Fixed Costs

<table>
<thead>
<tr>
<th>Cost</th>
<th>One-time Cost (2018 dollars)</th>
<th>Annual Cost (2018 dollars)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database Maintenance</td>
<td></td>
<td>40,000</td>
<td>Wisconsin Assembly Bill 75: Fiscal Estimates from District Attorney's Office and Department of Health Services</td>
</tr>
<tr>
<td>DHS Marijuana Testing</td>
<td>2,500</td>
<td>45,300</td>
<td>Wisconsin Assembly Bill 75: Fiscal Estimates from Department of Health Services</td>
</tr>
<tr>
<td>DHS Dispensary Inspector</td>
<td>2,500</td>
<td>79,100</td>
<td>Wisconsin Assembly Bill 75: Fiscal Estimates from Department of Health Services</td>
</tr>
<tr>
<td>State of Wisconsin Employee Costs</td>
<td>10,000</td>
<td>287,400</td>
<td>Wisconsin Assembly Bill 75: Fiscal Estimates from District Attorney's Office and Department of Health Services</td>
</tr>
<tr>
<td>DWD Reprint of WI Fair Housing Laws</td>
<td>5,000</td>
<td></td>
<td>Wisconsin Assembly Bill 75: Fiscal Estimates from Department of Workforce Development</td>
</tr>
<tr>
<td>DHS Rule Promulgation</td>
<td>60,000</td>
<td></td>
<td>Wisconsin Assembly Bill 75: Fiscal Estimates from Department of Health Services</td>
</tr>
<tr>
<td>Dispensary Application and Operating Fees</td>
<td>-2,500</td>
<td>-50,000</td>
<td>Wisconsin Assembly Bill 75: Fiscal Estimates from Department of Health Services</td>
</tr>
<tr>
<td>Dispensary Tax Revenue</td>
<td>-252,500</td>
<td></td>
<td>Wisconsin Assembly Bill 75: Fiscal Estimates from Department of Health Services</td>
</tr>
<tr>
<td>Database Set-up</td>
<td>400,000</td>
<td></td>
<td>Wisconsin Assembly Bill 75: Fiscal Estimates from Department of Health Services</td>
</tr>
<tr>
<td><strong>Total Costs:</strong></td>
<td><strong>225,000</strong></td>
<td><strong>401,800</strong></td>
<td></td>
</tr>
</tbody>
</table>
Table 12: Administrative Variable Costs

<table>
<thead>
<tr>
<th>Cost</th>
<th>Annual cost per user ($)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registry Card Costs</td>
<td>5.00</td>
<td>Wisconsin Assembly Bill 75: Fiscal Estimates from District Attorney's Office and Department of Health Services</td>
</tr>
<tr>
<td>Yearly Individual Fee Revenue</td>
<td>-37.50</td>
<td>Wisconsin Assembly Bill 75: Fiscal Estimates from Department of Health Services</td>
</tr>
<tr>
<td>Total Costs per user:</td>
<td>-32.50</td>
<td></td>
</tr>
</tbody>
</table>

**Benefits calculation.**

Administrative benefits accrue based on fee revenue. Registry card costs are subtracted from yearly fee revenue of $37.50, meaning the government sees administrative benefits of $32.50 for each member of the registry. Yearly costs of $401,800 are subtracted from this benefit to get a net benefit; this total is multiplied by a conservative marginal excess tax burden of .25 to get a yearly final net benefit (Boardman et al. 2017); these amounts are discounted at the end of each year. At the end of this calculation, the initial startup costs of $225,000 are subtracted out.

For each of the five years:

\[
A = \text{population}; \quad B = \text{percent of population on registry}
\]

\[
\text{Benefits} = \frac{\left(32.50AB - 401,800\right) \times 0.25}{\text{discount rate}} = C
\]

At the end of five years:

\[
\text{Total Net Administrative Benefits} = C - 225,000
\]
APPENDIX M: Calculation of Avoided Arrest, Court, and Jail Costs

Avoided Arrest Costs
We expect a substantial reduction in the number of arrests for small amounts of marijuana possession following decriminalization. The avoided arrest costs are considered a benefit. To estimate this benefit we find the marginal cost of an arrest and then multiply it by the number of expected avoided arrests. To find the marginal cost of an arrest in Wisconsin, we use the marginal cost of an arrest and the per arrest capital costs calculated by Fredricks et al. (2010). To estimate the expected number of avoided arrests we first find the average arrest rate for marijuana possession offenses between 2013 and 2017 using arrest data from the Wisconsin Department of Justice. This data only includes arrests where the possession of marijuana was the most serious offense. It does not include other marijuana related arrests. We then estimate the percentage of avoided arrests by assuming that police behavior in Wisconsin will be similar to other states that have decriminalized or legalized small amounts of marijuana. We also expect that some arrests for marijuana possession will continue after decriminalization because some individuals will continue to possess amounts of marijuana above the decriminalized limit or otherwise violate the terms of decriminalization. To account for these two assumptions, we assume that 70 percent of current arrests would be avoided. In our sensitivity analysis, we allow the number of arrests to fluctuate based on the highest and lowest annual arrest rates observed in the sample between 2013 and 2017. The estimates we used for marginal arrest costs, average arrest rate, and percentage of avoided arrests are reported below:
**Table 13: Arrest Cost Calculations**

<table>
<thead>
<tr>
<th>Marginal Arrest Cost</th>
<th>$718 (2018 dollars)</th>
</tr>
</thead>
</table>
| Average Arrest Rate, 2013-2017 (THC possession, per 100,000) | Average: 213  
High: 251  
Low: 220 |
| Percentage of Avoided Arrests | 70 percent |

**Avoided Court Costs**

We also expect a substantial reduction in the number of court proceedings for marijuana possession charges following decriminalization. The avoided court costs are considered a benefit. To estimate the benefits associated with avoided court costs, we first find the marginal cost of a drug related offense and then multiply it by the estimated number of avoided court cases. Our estimate of the marginal court costs associated with marijuana possession are from Fredericks et al. (2010). To estimate the number of avoided court cases, we use data from the Wisconsin State Council on Alcohol and Other Drug Abuse Prevention Committee to find the number of court cases for marijuana possession charges in 2013. We divide this number by the number of marijuana possession arrests in 2013 to estimated number of avoided court cases as a percentage of arrests. To estimate the full number of avoided court appearances we assume that the number of court cases decreases in proportion to the decrease in arrests.

**Table 14: Court Cost Calculations**

<table>
<thead>
<tr>
<th>Marginal Court Cost</th>
<th>$215 (2018 dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of Arrests Resulting in Court</td>
<td>34 percent</td>
</tr>
<tr>
<td>Number of Avoided Court Appearances</td>
<td>(Population)<em>(Arrest Rate)</em>(0.34)</td>
</tr>
</tbody>
</table>
Avoided Jail Costs

Consistent with the predicted reduction in arrests and court appearances due to decriminalization, we expect a substantial decrease in the number of individuals confined to county jails because of marijuana possession charges. We estimate the avoided costs associated with jail time using data from the Wisconsin State Council on Alcohol and Other Drug Abuse Prevention Committee and the Washington State Institute for Public Policy (WSIPP 2010). We calculate the marginal cost of an avoided jail sentence by using annual average cost estimates from the fiscal estimates reported by LFB and applying the ratio between average annual per-inmate costs and short-run marginal costs calculated by WSIPP. We use this method because we do not have access to the jail expenditure data needed to find marginal incarceration costs directly. We use short-run marginal costs because we do not expect the effect of our policy to appreciably change jail staffing levels when applied to the entire state.

To estimate the number of avoided jail sentences we use the reported number of individuals who were incarcerated in 2013 for marijuana possession and assume that all such sentences are avoided. To account for potential fluctuations in arrest and conviction rate over the valuation period we apply this estimate as a percentage of arrests. We assume that all jail sentences for marijuana possession are avoided based on data from Milwaukee County between 2012 and 2015 that shows of the 4,554 total marijuana possession cases where the defendant was found guilty, only eight actually served any jail time (0.18 percent). We use Milwaukee County as a valid comparison because marijuana was decriminalized in 1997. We estimate the length of each avoided jail sentence using data provided in the Marijuana Ad-Hoc Committee’s report on average sentence length, conditional on original sentencing outcome. To account for the
considerable variance in sentence length and actual time served, we uniformly distribute the length of jail time between 60 and 180 days.

Table 15: Jail Cost Calculations

<table>
<thead>
<tr>
<th></th>
<th>Average Cost</th>
<th>Short-Run Marginal</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washington (Jail)</td>
<td>$28,900</td>
<td>$3,457</td>
<td>1:0.12</td>
</tr>
<tr>
<td>Wisconsin (Jail)</td>
<td>$18,800</td>
<td>$2,248</td>
<td>1:0.12</td>
</tr>
</tbody>
</table>

Table 16: Jail Length Calculations

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of Arrests that Ultimately Result in Incarceration</td>
<td>4.5</td>
</tr>
<tr>
<td>Average Sentence Length in days</td>
<td>71 (Conditional on initially sentence)</td>
</tr>
<tr>
<td></td>
<td>120 (Conditional on time served)</td>
</tr>
<tr>
<td>Sentence Range in days</td>
<td>60 to 180</td>
</tr>
</tbody>
</table>
APPENDIX N: Calculation of Increased Adult and Adolescent Emergency Room Visits

Adult Use and Emergency Room (ER) Visits
A 1993 study examining the effects of decriminalization on hospitalizations due to marijuana between 1975-1978 in 12 US states found that marijuana decriminalization was associated with a decrease in emergency room “episodes” from drugs other than marijuana, but an increase in marijuana episodes. The author explains that the findings suggest that “the drastic reduction in penalties associated with marijuana use may have precipitated a substitution towards marijuana and away from other drugs” (Model 1993). Data was based on statistics from the Drug Abuse Warning Network (DAWN) through SAMHSA and did not specify medical marijuana legalization, only decriminalization. A more recent, 2017, study that looked at legalized medical marijuana and its association with ER visits for marijuana abuse and opioid abuse found that “medical marijuana policies had no associations with marijuana-related hospitalizations” but it did find that such policies were related to a reduction in opioid related hospitalizations (Shi 2017). Based on research in this area we assume no effect on ER visits as a result of medical marijuana legalization. We do, however, estimate potential costs in the case of decriminalization of marijuana.

As decriminalization is one of our alternatives, we use the Model 1993 study as a basis for calculating increase of marijuana ER visits based on the statistical increase in marijuana mentions found. Model claims that there is a 56 to 64 percent increase in marijuana mentions if marijuana decriminalized and estimates that this is an increase of 25 mentions per quarter, or 100 mentions per year per SMSA. Since SMSAs do not represent entire states, we calculated that the
average mention per 100,000 people is 7.75 mentions. These mentions will represent increased
annual ER visits per 100,000 people and will be used to calculate the cost of increased ER visits.

**Shadow Prices for ER Treatment**

We used Wisconsin Price Point data to estimate a charge estimate of $2,424 per “treated and
released” visit on the statewide median cost of inpatient services for alcohol use and dependence.
Our goal is to present a conservative and inclusive estimate of costs related to treatment for this
population. It is likely that these estimates overstate the cost of treatment for marijuana abuse
disorder among adults. It is important to note that this measure does not consider the benefits of
reduced ER visits due to other drug episodes with decriminalization, as cited by research above.

**Table 17: Wisconsin ER charge information for “Alcohol-related Disorders,” July 2017 to
June 2018**

<table>
<thead>
<tr>
<th>Number of Cases</th>
<th>Lower Charge</th>
<th>Median Charge</th>
<th>Higher Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>20,071</td>
<td>$950</td>
<td>$2,424</td>
<td>$4,204</td>
</tr>
</tbody>
</table>

(“Wisconsin Price Point” 2018)

**Calculating Cost of Increased ER Visits due to Decriminalization**

To estimate the monetary cost of increased ER visits due to
decriminalization, we multiply
the estimate of increased
mentions per 100,000 by the
estimated population in the five
years after legalization and by

Figure 10: Rates of ER Visits Involving Illicit Drugs among Patients Aged 12 to 24 per 100,000 Population, by Age Group
the median cost of ER visits. This calculation is represented as:

\[ \text{Sum}\left(\frac{7.75}{100,000}\right) \times (\$2,424) \times (\text{WI Population by year for 5 years}) = \text{total cost of increased ER visits due to decriminalization.} \]

**Adolescent Use and ER Visits**

A 2012 report from DAWN examined rising marijuana-related emergency department visits among adolescents aged 15-17 between 2005-2009 and found that for both males and females, emergency visits increased by 54 percent and 43 percent, respectively (DAWN, 2012). However, DAWN does not attribute these increases to legalization or decriminalization of marijuana, medical or otherwise. Another report by DAWN showed overall ER visits due to marijuana consumption and reported an increase of 52 percent of visits because of marijuana from 2004-2011, and a 19 percent increase from 2009-2011 (DAWN, 2013). It is important to note that these data represent ER visits that include marijuana, but are not necessarily only because of marijuana. Because of the lack of data specific to medical marijuana legalization and the potential confounding factors related to other substances that could be attributed to the ER visits, we assume no change in adolescent ER visits from use of marijuana due to the legalization of medical marijuana.
Figure 11: Drug-related deaths by drug category, 2009-2010

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL DRUGS</td>
<td>166</td>
<td>156</td>
<td>45</td>
<td>16</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td>Alcohol</td>
<td>46</td>
<td>38</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cocaine</td>
<td>55</td>
<td>47</td>
<td>22</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Marijuana</td>
<td>32</td>
<td>10</td>
<td>0</td>
<td>6</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Stimulants</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Club drugs</td>
<td>29</td>
<td>4</td>
<td>0</td>
<td>8</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Hallucinogens</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Inhalants</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Antidepressants</td>
<td>19</td>
<td>4</td>
<td>0</td>
<td>6</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Antipsychotics</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Benzodiazepines</td>
<td>90</td>
<td>57</td>
<td>0</td>
<td>8</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Misc. anxiolytics, sedatives, and hypnotics</td>
<td>32</td>
<td>10</td>
<td>0</td>
<td>6</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Opiate/opioids</td>
<td>138</td>
<td>77</td>
<td>0</td>
<td>4</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Methadone</td>
<td>44</td>
<td>29</td>
<td>0</td>
<td>8</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>All other opiates/opioids</td>
<td>109</td>
<td>77</td>
<td>0</td>
<td>4</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Nonsteroidal anti-inflammatory agents</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Salicylates/combinations</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Misc. analgesics/combinations</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Anticonvulsants</td>
<td>12</td>
<td>9</td>
<td>0</td>
<td>6</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Muscle relaxants</td>
<td>12</td>
<td>9</td>
<td>0</td>
<td>6</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

Notes: Alcohol row includes alcohol in combination with other drugs (all ages); alcohol alone in decedents under age 21. Club drug row includes MDMA (Ecstasy), GHB, GBL, flunitrazepam (Rohypnol), and ketamine. Hallucinogens row includes PCP, LSD, and miscellaneous hallucinogens.


Table 1

<table>
<thead>
<tr>
<th>State-level Explanatory Variable</th>
<th>State-level Outcome Variable: Natural Log of Hospitalization Rates per 1000 Discharges Point Estimate (95% CI)</th>
<th>Marijuana Dependence or Abuse</th>
<th>opioid Dependence or Abuse</th>
<th>Opioid Pain Reliever Overdose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Marijuana Policy</td>
<td>0.16 (-0.076, 0.41)</td>
<td>-0.23 (-0.41, -0.068)</td>
<td>-0.13 (-0.25, -0.018)</td>
<td></td>
</tr>
<tr>
<td>Marijuana Decriminalization Policy</td>
<td>0.13 (-0.016, 0.36)</td>
<td>0.094 (-0.15, 0.33)</td>
<td>0.049 (-0.22, 0.32)</td>
<td></td>
</tr>
<tr>
<td>Prescription Drug Monitoring Program</td>
<td>-0.088 (-0.21, 0.042)</td>
<td>0.020 (-0.088, 0.12)</td>
<td>0.027 (-0.088, 0.13)</td>
<td></td>
</tr>
<tr>
<td>Pain Clinic Regulation</td>
<td>-0.046 (-0.17, 0.078)</td>
<td>0.052 (-0.12, 0.23)</td>
<td>-0.070 (-0.16, 0.025)</td>
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</tr>
<tr>
<td>Number of State-Year Observations</td>
<td>382</td>
<td>7</td>
<td>4</td>
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</tr>
<tr>
<td>Number of Discharges</td>
<td>2,237,916</td>
<td>2,176,326</td>
<td>376,080</td>
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</tr>
<tr>
<td>R²</td>
<td>0.90</td>
<td>0.98</td>
<td>0.97</td>
<td></td>
</tr>
</tbody>
</table>

Note: The linear regressions also controlled for state and year fixed effects and state-level time-varying covariates including natural log of population size, unemployment rate, natural log of median household income in constant 2014 dollars, natural log of beer tax per gallon in constant 2014 dollars, and health uninsured rate.

*p < 0.05.

**p < 0.01.
Table 2


<table>
<thead>
<tr>
<th>State-level Explanatory Variable</th>
<th>State-level Outcome Variable: Natural Log of Hospitalization Rates per 1000 Discharges</th>
<th>Point Estimate (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Marijuana Dependence or Abuse</td>
<td>Opioid Dependence or Abuse</td>
</tr>
<tr>
<td>Medical Marijuana Policy</td>
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<td>-0.22</td>
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<tr>
<td>Operation of Medical Marijuana Dispensaries</td>
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<td>Marijuana Decriminalization Policy</td>
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<td>Prescription Drug Monitoring Program</td>
<td>-0.086</td>
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<td>Pain Clinic Regulation</td>
<td>-0.077</td>
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<tr>
<td>Number of State-Year Observations</td>
<td>382</td>
<td>382</td>
</tr>
<tr>
<td>Number of Discharges</td>
<td>2,237,916</td>
<td>2,176,329</td>
</tr>
</tbody>
</table>

Note: The linear regressions also controlled for state and year fixed effects and state-level time-varying covariates including natural log of population size, unemployment rate, natural log of median household income in constant 2014 dollars, natural log of beer tax per gallon in constant 2014 dollars, and health uninsured rate. Bold value highlighted statistics with p value smaller than .05.

Table 3


<table>
<thead>
<tr>
<th>State-level Explanatory Variable</th>
<th>State-level Outcome Variable: Natural Log of Hospitalization Rates</th>
<th>per 1000 Discharges</th>
<th>Point Estimate (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Marijuana Dependence or Abuse</td>
<td>Opioid Dependence or Abuse</td>
<td>Opioid Pain Reliever Overdose</td>
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<td>Medical Marijuana Policy, Leads:</td>
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<td>2 year lead</td>
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<tr>
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<tr>
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<td>-0.012</td>
<td>-0.036</td>
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<tr>
<td>3 year lag</td>
<td>0.062</td>
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<td>-0.084</td>
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<td>Marijuana Decriminalization Policy</td>
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<td>0.011</td>
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<td>Prescription Drug Monitoring Program</td>
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<td>-0.022</td>
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<td>Pain Clinic Regulation</td>
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<td>-0.171</td>
<td>-0.018</td>
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<td>Number of State-Year Observations</td>
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<td>382</td>
<td>382</td>
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<td>2,237,916</td>
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<td>376,680</td>
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</table>

R²

Note: The linear regressions also controlled for state and year fixed effects and state-level time-varying covariates including natural log of population size, unemployment rate, natural log of median household income in constant 2014 dollars, natural log of beer tax per gallon in constant 2014 dollars, and health uninsured rate. Bold value highlighted statistics with p value smaller than .05.

Figure 12: Association between Medical Marijuana Implementation and Hospitalization Rates
APPENDIX O: Calculation of Pediatric Exposures to Marijuana after Medical Marijuana Legalization

Studies have shown an increase in exposures to marijuana in children under the age of 12 following the legalization of marijuana for medicinal purposes. In a retrospective cohort study comprised of records from a children’s hospital in Colorado, Wang et al found a significant increase in unintentional marijuana ingestions by young children following the modification of drug enforcement laws for medical marijuana (Wang et al. 2013). The majority of these exposures were for very young children and were associated with edible marijuana products. Cao et al. (2016) similarly found an increase in edible marijuana exposures across the United States, with the highest rates of exposures in Colorado and Washington. Onders et al. (2015) examined marijuana exposures among children younger than six years in the United States and found that among “transitional states,” states with laws legalizing the medical use of marijuana that went into effect 2000-2013, marijuana exposure in young children increased after legalization. We use information from these studies and additional data to calculate expected unintentional exposures in children under the age of 12 and estimate the costs of those exposures.

Calculating Unintentional Exposures

We anticipate that Wisconsin will have unintentional exposures similar to transitional states identified by Onders et al. They present the following chart, which documents rates of marijuana exposure per 1 million children under the age of 6 in the years before and after legalization of marijuana for medical use in transitional states.
Using this graph and conservative estimates, we estimate that the number of exposures per million children under the age of 6 will increase from around 5 per year before legalization to about 25 per year after legalization, resulting in a net increase of 20 exposures per million children under the age of 6.

Cao et al. (2016) estimates the rate of exposure to edible marijuana products in ages younger than 6 to be .15 exposures per 100,000 population per year, and the rate of exposure to edible marijuana products in ages younger 6-12 as .04 exposures per population per year. Using a cumulative exposure of .19 per 100,000 population per year and the .15 exposures per population per year in children under the age of 6, we estimate that the additional 20 exposures per million children under the age of 6 represents 78 percent of potential additional exposures to marijuana in children under the age of 12, and the total number of additional exposures is 20/.78 or 25.64 additional exposures per million children.
The Onders et al. (2015) study found that of children with exposures to marijuana, 29.1 percent were treated and released, 11.6 percent were admitted to non-critical care, and 6.9 percent were admitted to critical care. We assume that the origin for treatment is an emergency department setting and use these percentages to estimate the disposition of additional annual pediatric exposures to marijuana following legalization:

*Table 18: Pediatric marijuana exposure disposition in children I*

<table>
<thead>
<tr>
<th>Exposure Disposition</th>
<th>Percentage of Total</th>
<th>Count per Million Children Under the age of 12</th>
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</thead>
<tbody>
<tr>
<td>All Exposures</td>
<td>100</td>
<td>25.64</td>
</tr>
<tr>
<td>Treated and released</td>
<td>29.1</td>
<td>7.46</td>
</tr>
<tr>
<td>Inpatient admission</td>
<td>11.6</td>
<td>2.97</td>
</tr>
<tr>
<td>Critical care treatment</td>
<td>6.9</td>
<td>1.76</td>
</tr>
</tbody>
</table>

*Shadow Prices for Treatment*

We used Wisconsin Price Point data to estimate a charge estimate of $2,424 per “treated and released” visit based on the statewide median cost of inpatient services for alcohol use and dependence. We used the same source to estimate a statewide charge average of $12,207 for inpatient admissions and critical care treatment, based on the statewide charge averages for inpatient other substance abuse/dependence. Our goal is to present an inclusive estimate of costs related to treatment for this vulnerable population; it is likely that these estimates overstate the cost of treatment for pediatric exposures.
Table 19: Pediatric marijuana exposure disposition in children II

<table>
<thead>
<tr>
<th>Exposure disposition</th>
<th>Percentage of total</th>
<th>Count per million children under the age of 12</th>
<th>Per exposure cost estimate for medical treatment (dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Exposures</td>
<td>100</td>
<td>25.64</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Treated and released</td>
<td>29.1</td>
<td>7.46</td>
<td>$2424</td>
</tr>
<tr>
<td>Inpatient admission</td>
<td>11.6</td>
<td>2.97</td>
<td>$12207</td>
</tr>
<tr>
<td>Critical care treatment</td>
<td>6.9</td>
<td>1.76</td>
<td>$12207</td>
</tr>
</tbody>
</table>

Calculating Exposers and Costs

Based on the following population percentage information from GetFacts we estimate that children under the age of 12 represent 13.63 percent of the Wisconsin population.

Table 20: Age and gender breakdown of Wisconsin youth

<table>
<thead>
<tr>
<th>Wisconsin population percentage description</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of total pop that are males ages 0-4</td>
<td>2.84</td>
</tr>
<tr>
<td>Percent of total pop that are males ages 5-9</td>
<td>3.01</td>
</tr>
<tr>
<td>Percent of total pop that are females ages 0-4</td>
<td>2.69</td>
</tr>
<tr>
<td>Percent of total pop that are females ages 5-9</td>
<td>2.87</td>
</tr>
<tr>
<td>Estimated percent of total pop ages 10-11 [calculated as (percent of total pop male ages 10-14 + percent of total pop female ages 10-14) * .4 ]</td>
<td>2.224</td>
</tr>
<tr>
<td>Estimated percent of pop under 12 years of age (sum of preceding rows)</td>
<td>13.634</td>
</tr>
</tbody>
</table>

To calculate exposures, dispositions, and costs in our Monte Carlo simulation, we:

- Estimated the Wisconsin population of children under the age of 12 by multiplying the total estimated population point estimate (5,865,519) by .13634 to determine an estimated population of 799,704
- Divided the estimated population of children under the age of 12 by one million to determine the multiplier for each category of exposure (799,705/1,000,000 = .80)
- Determined the estimated annual count of each exposure based on that multiplier
- Multiplied the count of each exposure type by the relevant shadow price
- Summed the total of each exposure to determine overall estimated costs

**Table 21: Pediatric marijuana exposure costs**

<table>
<thead>
<tr>
<th>Exposure disposition</th>
<th>Percentage of total</th>
<th>Count per million children under the age of 12</th>
<th>Estimated WI Exposures (Count * .8)</th>
<th>Per exposure cost estimate for medical treatment (dollars)</th>
<th>Total cost per exposure type</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Exposures</td>
<td>100</td>
<td>25.64</td>
<td>20.512</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treated and released</td>
<td>29.1</td>
<td>7.46</td>
<td>5.968</td>
<td>$2,424</td>
<td>14,466</td>
</tr>
<tr>
<td>Inpatient admission</td>
<td>11.6</td>
<td>2.97</td>
<td>2.376</td>
<td>$12,207</td>
<td>29,003</td>
</tr>
<tr>
<td>Critical care treatment</td>
<td>6.9</td>
<td>1.76</td>
<td>1.408</td>
<td>$12,207</td>
<td>17,187</td>
</tr>
<tr>
<td>Total Annual Costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>61,000</td>
</tr>
</tbody>
</table>

The annual costs are incurred in each of the five years and discounted according to the standard discount rate used throughout the analysis. In our Monte Carlo analysis, exact costs vary based on the parameters of initial population and population growth.
APPENDIX P: Calculation of Cost and Decrease in Fatal Car Accidents

Research on Impaired Driving

As traffic accidents are already a leading cause of death in Wisconsin, there is considerable interest in understanding the relationship between medical marijuana and driving performance, particularly as it relates to accident risk and traffic fatalities. This section outlines the available evidence on the risks of driving while under the influence of marijuana.

One approach to examining the relationship between impaired driving and accident risk is to use driving simulators in a laboratory setting to compare the performance between intoxicated and sober subjects under a variety of traffic and road conditions. A review of this literature finds that marijuana use impairs driving performance. Bondallaz et al. (2017) finds that subjects under the influence of marijuana had lower mean following distances and higher rates of lane weaving than sober subjects. However, they note that numerous studies provide conflicting evidence on the performance effects of impaired driving. Moreover, they report that the mechanisms underlying the effects of cannabis use on driving performance remain poorly understood and that the correlation between different dosages of marijuana and driving performance are weak. Meta-analyses that examine the relationship between marijuana consumption and driving performance also find mixed evidence on an effect. Hostiuc et al. (2018) found a statistically insignificant effect in the risk of various unfavorable traffic events, but Li et al. (2011) found a statistically significant increase in motor vehicle crash risk while under the influence of marijuana.

A second approach is to use roadside surveys to estimate the proportion of drivers who have used cannabis. These efforts are generally very expensive, but often preferred by government agencies. The National Highway Traffic Safety Administration (NHTSA) has conducted several
of these studies in the United States. Results from these studies show that the percentage of drivers with elevated (non-zero) blood alcohol levels have decreased and the percentage of drivers with elevated (non-zero) THC levels have increased. The NHTSA also conducted a comprehensive crash risk study in which more than 3,000 crash-involved drivers and 6,000 control drivers were studied. The study found that when demographic factors and the presents of alcohol were controlled for, marijuana use was not associated with an increased risk of crash involvement (Compton 2017).

Taken together, both approaches suggest that concerns about the relationship between traffic accidents and the legalization of marijuana are well-founded, but subject to conflicting and contradictory evidence. Indeed, comprehensive reviews of the literature have consistently noted that the evidence is mixed and contradictory, both within approaches and across disciplines (Ramaekers et al. 2004; Sewell et al. 2009).

**Research on Medical Marijuana Laws and Traffic Fatalities**

To address the concerns posed in the literature on marijuana use and impaired driving, this analysis turns to estimates that examine the relationship between medical marijuana laws and traffic fatalities. These studies use difference-in-differences to study the impact of state marijuana laws on traffic fatalities rather than the impact of cannabis use on driving performance. These studies do not suffer from the same types of limitations that the above-mentioned studies fail to overcome. Moreover, they estimate the complete impact of medical marijuana legalization of traffic fatalities and allow for a broader consideration of the effects of policy change. These studies find that medical marijuana laws result in statistically significant decreases in traffic fatality rates (Anderson et al. 2013; Santaella-Tenorio et al. 2017). While the
precise reason for the decline in traffic fatalities following the legalization of medical marijuana is not fully understood, it is reasonable to assume that pure substitution effects between marijuana and other intoxicants explains much of the difference. These substitution effects are well-known in the literature and there is strong evidence that marijuana is a substitute for alcohol and other drugs with higher accident risks than cannabis (Reiman 2009; Crost & Guerrero 2012; DiNardo & Lemieux 2001; Elvik 2013).

*Estimating the Aggregate Change in Traffic Fatalities*

To estimate the aggregate change in the number of traffic fatalities following the legalization of medical marijuana in Wisconsin, we use updated estimates of the association between medical marijuana laws and traffic fatality rates calculated by Santaella-Tenorio et al. (2017). Santaella-Tenorio and colleagues use data from the 1985-2014 Fatality Analysis Reporting System to examine the association between medical marijuana laws and traffic fatalities using multilevel regression models. The models are adjusted by the national trend in vehicle miles driven per licensed driver and a series of state-level covariates. They find that both medical marijuana laws and operational marijuana dispensaries are associated with a reduction in the rate of fatal traffic accidents. The results are almost identical to those by Anderson et al. (2013). To remain conservative in our estimates and account for the potential difference between states with and without marijuana dispensaries, we use the main effect for all ages in states with operational dispensaries. The traffic fatality rate in this estimate falls 2.7 percent after the enactment of a medical marijuana law.

To monetize the benefits associated with the reduction in fatal accidents we apply the fatal accident rate differential to the average number of annual fatal accidents in Wisconsin between
2013 and 2017. This estimate is multiplied by the average number of fatalities per accident to find the number of avoided deaths. The number of avoided deaths is multiplied by the value of statistical life estimated by Viscusi and Masterman (2017) to find the benefit of each avoided death. In our sensitivity analysis, we allow the change in the fatality rate to vary within a normal distribution consistent with the confidence interval reported by Santaella-Tenorio et al. (2017). We also allow the number of initial traffic fatalities to fluctuate uniformly between the minimum and maximum values reported between 2013-2017. The values used for each calculation are reported in the figures below.

**Omission of Non-Fatal Accident Costs**

We do not include an analysis of less serious traffic accidents for two reasons. First, the cost of motor vehicle accidents that result in injury vary considerably, ranging from $20,812 to $3,329,831 depending on severity. Accident data from Wisconsin does not report accident severity nor does the literature, making this estimate highly uncertain and difficult to calculate. Second, available research does not provide aggregate crash statistics on cannabis use and traffic accidents beyond individual crash risk, making it impossible to accurately estimate the magnitude of the effect. It is also not clear from this research if marijuana impaired drivers have significantly different driving patterns or habits than sober drivers, making it difficult to compare isolated risk factors to aggregate statistics. Importantly, if we were to estimate the association between medical marijuana and traffic accidents in general, then we would expect a decrease in traffic accidents similar to that of fatal accidents. In view of the uncertainty surrounding this calculation, however, we remain conservative in our estimate of net benefits and do not include this expected benefit in our calculation.
APPENDIX Q: Current State Laws Regarding Marijuana

Table 22: State Marijuana Laws

<table>
<thead>
<tr>
<th>State</th>
<th>Decriminalized?</th>
<th>Medical?</th>
<th>Recreational?</th>
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</tr>
<tr>
<td>WV</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>WI</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>WY</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>DC</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Total Yes</td>
<td>24</td>
<td>33</td>
<td>11</td>
</tr>
<tr>
<td>Total No</td>
<td>27</td>
<td>18</td>
<td>40</td>
</tr>
</tbody>
</table>
APPENDIX R: Legislative Reference Bureau Summary of 2017 Assembly Bill 75

Current law prohibits a person from manufacturing, distributing, or delivering marijuana; possessing marijuana with the intent to manufacture, distribute, or deliver it; possessing or attempting to possess marijuana; using drug paraphernalia; or possessing drug paraphernalia with the intent to produce, distribute, or use a controlled substance. This bill creates a medical use defense to such marijuana-related prosecutions and forfeiture actions for persons who are registered with the Department of Health Services as having specified debilitating medical conditions or treatments and, if applicable, their primary caregivers. This bill also prohibits the arrest or prosecution of such persons for those offenses. The defense and prohibition do not apply under certain circumstances, such as 1) if the person does not have a valid registry identification card; 2) if the amount of marijuana involved is more than 12 marijuana plants and three ounces of marijuana leaves or flowers; 3) if, while under the influence of marijuana, the person drives a motor vehicle or engages in any other conduct that endangers the health or well-being of another person; or 4) if the person smokes marijuana on a school bus or public transit or on school premises.

Under the bill, DHS must establish a registry for persons who use marijuana for medical use. Under the bill, a person may apply to DHS for a registry identification card. DHS must issue a qualified applicant a registry identification card unless, in the previous ten years, the applicant was serving a sentence or on probation for certain felony convictions. Except for law enforcement purposes, DHS must keep registry information and applications confidential.
Under the bill, DHS also must license and regulate dispensaries to facilitate the medical use of marijuana. This bill prohibits dispensaries from being located within 500 feet of a school, prohibits a dispensary from distributing to one person more than an allowable amount of marijuana, and prohibits a dispensary from possessing an excessive quantity of marijuana as determined by the number of persons it serves or by DHS. An applicant for a license must pay an initial application fee of $250, and a dispensary must pay an annual fee of $5,000.

This bill requires DHS to promulgate rules to allow entities to grow marijuana and distribute marijuana to dispensaries. This bill also requires DHS to register entities as tetrahydrocannabinols-testing laboratories.

This bill changes state law regarding marijuana. It does not affect federal law, which generally prohibits persons from manufacturing, delivering, or possessing marijuana and applies to both intrastate and interstate violations.
APPENDIX S: Wisconsin Referenda Results Regarding Marijuana Legalization

Bolded if referendum question asked about medical, non-bolded if referendum question asked about recreational.

Table 23: Fall 2018 Wisconsin Marijuana Referenda Results

<table>
<thead>
<tr>
<th>County + Major Cities</th>
<th>Question Wording</th>
<th>% Vote in Favor(^\text{10})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown (Green Bay)</td>
<td>“Should cannabis be legalized in Wisconsin for medical purposes, and regulated in the same manner as other prescription drugs?”(^\text{11})</td>
<td>75.6</td>
</tr>
<tr>
<td>City of Racine</td>
<td>Unavailable</td>
<td>87.7</td>
</tr>
<tr>
<td>City of Waukesha</td>
<td>“Should cannabis be legalized in Wisconsin for medical purposes, and regulated in the same manner as other prescription drugs?”(^\text{12})</td>
<td>76.6</td>
</tr>
<tr>
<td>Clark (Neillsville, Thorp, Abbotsford)</td>
<td>“Should the state of Wisconsin legalize the use of marijuana for medical purposes and regulate its use in the same manner as other prescription drugs?”(^\text{13})</td>
<td>67.1</td>
</tr>
<tr>
<td>Forest (Crandon, Wabeno)</td>
<td>Unavailable</td>
<td>78.7</td>
</tr>
<tr>
<td>Kenosha (Kenosha)</td>
<td>“Should the state of Wisconsin allow individuals with debilitating medical conditions to use and safely access marijuana for medical purposes, if those individuals have a</td>
<td>88.5</td>
</tr>
</tbody>
</table>

---


<table>
<thead>
<tr>
<th>County</th>
<th>Resolution</th>
<th>Poll Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Langlade (Antigo)</td>
<td>&quot;Shall the County of Langlade, Wisconsin, adopt the following resolution? RESOLVED, THAT “WE THE PEOPLES” OF LANGLADE COUNTY, WISCONSIN, SUPPORT THE RIGHT OF ITS CITIZENS TO ACQUIRE, POSSESS AND USE MEDICAL CANNABIS UPON THE RECOMMENDATION OF A LICENSED PHYSICIAN, AND; BE IT FURTHER RESOLVED, THAT WE STRONGLY SUPPORT A STATEWIDE REFERENDUM REQUESTING WISCONSIN TO JOIN WITH THIRTY-TWO (32) OTHER STATES THAT HAVE ALREADY APPROVED THE USE OF MEDICAL CANNABIS FOR THE TREATMENT OF CHRONIC PAIN, SEVERAL DEBILITATING DISEASES AND DISABLING SYMPTOMS.&quot;</td>
<td>77.3</td>
</tr>
<tr>
<td>Lincoln (Merrill, Tomahawk)</td>
<td>&quot;Should the State of Wisconsin allow individuals with debilitating medical conditions to use and safely access marijuana for medical [treatment] purposes, if those individuals have a written [treatment] recommendation from a licensed Wisconsin physician?&quot;</td>
<td>80.8</td>
</tr>
<tr>
<td>Marathon (Wausau)</td>
<td>&quot;Should the State of Wisconsin legalize marijuana so that people with debilitating medical conditions may access medical marijuana if they have a recommendation from a licensed Wisconsin physician?&quot;</td>
<td>81.6</td>
</tr>
<tr>
<td>Marquette (Montello, Endeavor)</td>
<td>&quot;Shall the County of Marquette, Wisconsin, adopt the following resolution? RESOLVED, THAT “WE THE PEOPLE” OF MARQUETTE COUNTY, WISCONSIN, SUPPORT THE RIGHT OF ITS CITIZENS TO ACQUIRE, POSSESS AND USE MEDICAL CANNABIS UPON THE RECOMMENDATION OF A LICENSED PHYSICIAN, AND; BE IT FURTHER RESOLVED, THAT WE STRONGLY SUPPORT A STATEWIDE REFERENDUM REQUESTING WISCONSIN TO JOIN WITH THIRTY-TWO (32) OTHER STATES THAT HAVE ALREADY APPROVED THE USE OF MEDICAL CANNABIS FOR THE TREATMENT OF CHRONIC PAIN, SEVERAL DEBILITATING DISEASES AND DISABLING SYMPTOMS.&quot;</td>
<td>77.6</td>
</tr>
<tr>
<td>Portage (Stevens Point, Plover)</td>
<td>&quot;Should the State of Wisconsin allow individuals with debilitating medical conditions to use and safely access marijuana for medical [treatment] purposes, if those individuals have a written [treatment] recommendation from a licensed Wisconsin physician?&quot;</td>
<td>83.0</td>
</tr>
<tr>
<td>Racine (Racine)</td>
<td>Unavailable</td>
<td>84.8</td>
</tr>
<tr>
<td>Sauk (Baraboo, Reedsburg)</td>
<td>&quot;Should the State of Wisconsin legalize marijuana so that people with debilitating medical conditions may access medical marijuana if they have a recommendation from a licensed Wisconsin physician?&quot;</td>
<td>80.0</td>
</tr>
<tr>
<td>City of</td>
<td>Unavailable</td>
<td>66.3</td>
</tr>
</tbody>
</table>

---

17 United States, Sauk County, WI. (2018). Sauk County - November 6, 2018 Candidate Listing.
<table>
<thead>
<tr>
<th>Location</th>
<th>Question</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dane (Madison)</td>
<td>“Should marijuana be legalized, taxed and regulated in the same manner as alcohol for adults 21 years of age or older?”(^{18})</td>
<td>76.4</td>
</tr>
</tbody>
</table>
| Eau Claire (Eau Claire) | “Should cannabis a) Be legal for adult, 21 years of age and older, recreational or medical use, taxed and regulated like alcohol, with the proceeds from the taxes used for education, healthcare, and infrastructure in Wisconsin? B) Be legal for medical purposes only and available only by prescription through a medical dispensary? C) Remain a criminally illegal drug as provided under current law?”\(^{19}\) | A 54.2  
B 31.2  
C 14.6  |
| La Crosse (La Crosse) | “Should the State of Wisconsin legalize the use of marijuana by adults 21 years or older, to be taxed and regulated in the same manner that alcohol is regulated in the State of Wisconsin, with proceeds from the taxes used for education, healthcare, and infrastructure?”\(^{20}\) | 63.3        |
| Milwaukee (Milwaukee) | Unavailable                                                                | 69.6        |
| Racine (Racine) | Unavailable                                                                | 60.2        |
| Rock (Janesville, Beloit) | Unavailable                                                                | 69.2        |


\(^{19}\) United States, Eau Claire County, WI. (n.d.). November 6, 2018 Election Results.

## APPENDIX T: All Quantified Values

**Table 24: All Quantified Values**

<table>
<thead>
<tr>
<th>Value &amp; Distribution</th>
<th>Point Estimate</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Discount Rate (%)</td>
<td>3.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial population (normal)</td>
<td>5,865,528</td>
<td>5,814,071</td>
<td>5,929,983</td>
</tr>
<tr>
<td>Population growth (normal) (%)</td>
<td>0.6</td>
<td>0.4</td>
<td>0.8</td>
</tr>
<tr>
<td>% of state on registry, year 1 (asymmetric triangular)</td>
<td>0.26</td>
<td>0.01</td>
<td>0.7</td>
</tr>
<tr>
<td>% of state on registry, year 2 (asymmetric triangular)</td>
<td>0.39</td>
<td>0.01</td>
<td>0.98</td>
</tr>
<tr>
<td>% of state on registry, year 3 (asymmetric triangular)</td>
<td>0.51</td>
<td>0.06</td>
<td>1.29</td>
</tr>
<tr>
<td>% of state on registry, year 4 (asymmetric triangular)</td>
<td>0.73</td>
<td>0.14</td>
<td>1.66</td>
</tr>
<tr>
<td>% of state on registry, year 5 (asymmetric triangular)</td>
<td>1.03</td>
<td>0.19</td>
<td>2.18</td>
</tr>
<tr>
<td>Total administrative benefits ($)</td>
<td>792,474</td>
<td>-104,885</td>
<td>1,756,600</td>
</tr>
<tr>
<td>Average length of jail sentence in days (normal)</td>
<td>120</td>
<td>60</td>
<td>180</td>
</tr>
<tr>
<td>Total jail benefits ($)</td>
<td>2,245,625</td>
<td>1,338,962</td>
<td>3,189,040</td>
</tr>
<tr>
<td>Total court benefits ($)</td>
<td>3,304,639</td>
<td>3,118,678</td>
<td>3,494,825</td>
</tr>
<tr>
<td>Total arrest benefits in millions ($)</td>
<td>32.5</td>
<td>30.6</td>
<td>34.3</td>
</tr>
<tr>
<td>Total justice benefits in millions ($)</td>
<td>38.0</td>
<td>35.8</td>
<td>40.6</td>
</tr>
<tr>
<td>Elasticity of demand for medical marijuana (uniform)</td>
<td>-0.73</td>
<td>-0.79</td>
<td>-0.67</td>
</tr>
<tr>
<td>Price per gram of medical marijuana (asymmetric triangular) ($)</td>
<td>10.43</td>
<td>6.21</td>
<td>12.34</td>
</tr>
<tr>
<td>Average quantity of medical marijuana purchased per user in grams (normal)</td>
<td>191.4</td>
<td>81.8</td>
<td>293.28</td>
</tr>
<tr>
<td>Value &amp; Distribution</td>
<td>Point Estimate</td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------------------</td>
<td>----------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>Total demand benefits in millions (flowers only) ($)</td>
<td>233</td>
<td>65.5</td>
<td>566</td>
</tr>
<tr>
<td>Total demand benefits in millions (concentrates only) ($)</td>
<td>197</td>
<td>44.8</td>
<td>576</td>
</tr>
<tr>
<td>Percentage of medical marijuana users who reduce opioid usage by &lt;50%</td>
<td>10.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of medical marijuana users who reduce opioid usage by &gt;50%</td>
<td>14.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimated reduced addiction risk for patients who reduce risk by &lt;50% (uniform) (%)</td>
<td>50</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>Estimated reduced addiction risk for patients who reduce risk by &gt;50% (uniform) (%)</td>
<td>80</td>
<td>70</td>
<td>90</td>
</tr>
<tr>
<td>Risk of fatal overdose for patients who are addicted to opioids (%)</td>
<td>4.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of opioid users addicted or at risk of addiction</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimated reduced overdose risk for patients who reduce risk by &lt;50% (uniform) (%)</td>
<td>2.1</td>
<td>1.68</td>
<td>2.52</td>
</tr>
<tr>
<td>Estimated reduced overdose risk for patients who reduce risk by &gt;50% (uniform) (%)</td>
<td>3.36</td>
<td>2.94</td>
<td>3.78</td>
</tr>
<tr>
<td>Shadow price of addiction ($)</td>
<td>32,286</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shadow price of overdose ($)</td>
<td>1,452,499</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total opioid reduction benefits in millions ($)</td>
<td>291</td>
<td>108</td>
<td>50.3</td>
</tr>
<tr>
<td>Value of a Statistical Life in millions (VSL) ($)</td>
<td>9.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage decrease in fatal car accidents due to medical marijuana implementation (normal)</td>
<td>2.7</td>
<td>-0.1</td>
<td>5.5</td>
</tr>
<tr>
<td>Deaths per fatal car accident</td>
<td>1.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yearly number of fatal car accidents in Wisconsin (uniform)</td>
<td>450</td>
<td>404</td>
<td>496</td>
</tr>
<tr>
<td>Value &amp; Distribution</td>
<td>Point Estimate</td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>--------------------------------------------------------------</td>
<td>----------------</td>
<td>-----------</td>
<td>----------</td>
</tr>
<tr>
<td>Total fatal accident reduction benefits in millions ($)</td>
<td>586</td>
<td>-731</td>
<td>1,840</td>
</tr>
<tr>
<td>Total benefits, decriminalization in millions ($)</td>
<td>1,150</td>
<td>48.6</td>
<td>2,650</td>
</tr>
<tr>
<td>Total benefits, non-decriminalization in millions ($)</td>
<td>1,110</td>
<td>11.6</td>
<td>2,610</td>
</tr>
<tr>
<td>Up-front administrative costs ($)</td>
<td>225,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yearly administrative costs ($)</td>
<td>401,800</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of Wisconsin population age &lt;12</td>
<td>13.64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child exposures to marijuana treated in ED per 100,000</td>
<td>7.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of pediatric ED visit ($)</td>
<td>2,424</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child exposures to marijuana admitted to hospital per 100,000</td>
<td>2.97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child exposures to marijuana treated in critical care per 100,000</td>
<td>1.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of pediatric admission to hospital ($)</td>
<td>12,207</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total costs of increased pediatric ED visits ($)</td>
<td>283,579</td>
<td>280,009</td>
<td>286,631</td>
</tr>
<tr>
<td>Increased ER admissions due to decriminalization per 100,000</td>
<td>7.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total costs of increased non-pediatric ED visits in millions ($)</td>
<td>5.15</td>
<td>5.09</td>
<td>5.21</td>
</tr>
<tr>
<td>Total costs of public health campaign in millions ($)</td>
<td>3.51</td>
<td>1.50</td>
<td>5.50</td>
</tr>
<tr>
<td>Total costs, decriminalization in millions ($)</td>
<td>8.95</td>
<td>6.90</td>
<td>11.0</td>
</tr>
<tr>
<td>Total costs, non-decriminalization in millions ($)</td>
<td>3.80</td>
<td>1.78</td>
<td>5.78</td>
</tr>
<tr>
<td><strong>NET PRESENT VALUE – Decriminalization in millions ($)</strong></td>
<td><strong>1,140</strong></td>
<td><strong>38.3</strong></td>
<td><strong>2,639</strong></td>
</tr>
<tr>
<td>Value &amp; Distribution</td>
<td>Point Estimate</td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
<td>----------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>NET PRESENT VALUE - Non-decriminalization in millions ($)</td>
<td>1,107</td>
<td>6.43</td>
<td>2,605</td>
</tr>
</tbody>
</table>
APPENDIX U: NASEM Report

To illustrate the current state of the research, we present findings from the National Academy of Science, Engineering, and Medicine on the health effects of cannabis and cannabinoids.


Table 25: NASEM Report Summary

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Systematic Review Summary</th>
<th>NASEM Conclusion</th>
<th>Sources</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic Pain</td>
<td>Five good quality systematic reviews were identified to determine cannabis or cannabinoids as effective treatment for the reduction of chronic pain. Studies of cannabis for treatment of pain supported by clinical trials, but data regarding efficacy, dose, administration, and side effects in the US are not. The committee suggests additional need for research on various forms of cannabis, routes of administration, and combination of cannabinoids.</td>
<td>CONCLUSION 4-1 There is substantial evidence that cannabis is an effective treatment for chronic pain in adults.</td>
<td>Systematic review: Andreae et al. 2015; Fitzcharles et al., 2016; Richards et al. 2012; Snedecor et al. 2013; Whiting et al. 2015</td>
<td>90</td>
</tr>
<tr>
<td>Cancer</td>
<td>One systematic review identified to study cannabis or cannabinoids an effective treatment for cancer. Significant anti-tumor effect of cannabinoids for 16 preclinical studies. But ultimately there is insufficient data to determine effectiveness.</td>
<td>CONCLUSION 4-2 There is insufficient evidence to support or refute the conclusion that cannabinoids are an effective treatment for cancers, including glioma.</td>
<td>Rocha et al. 2014</td>
<td>91</td>
</tr>
<tr>
<td>Conditions</td>
<td>Systematic Review Summary</td>
<td>NASEM Conclusion</td>
<td>Sources</td>
<td>Page</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Chemotherapy-Induced Nausea and Vomiting</td>
<td>Three systematic reviews identified to study cannabis or cannabinoids as effective treatments for the reduction of chemotherapy-induced nausea and vomiting. 56 trials represented among these 3 studies. Conclusion trials suggest greater benefit for cannabinoids than active agents and placebo (not all statistically significant)</td>
<td>CONCLUSION 4-3 There is conclusive evidence that oral cannabinoids are effective antiemetics in the treatment of chemotherapy-induced nausea and vomiting</td>
<td>Philips et al. 2016; Smith et al. 2015; Whiting et al. 2015</td>
<td>Page 92</td>
</tr>
<tr>
<td>Anorexia and Weight Loss</td>
<td>HIV/AIDS: two systematic reviews showed some increase in weight with use of MM, no significant evidence regarding appetite; Anorexia Nervosa: no systematic reviews, trial (Adries et al. 2014) found weight gain with cannabinoids but no effect on attitude for eating disorder, small sample; Cancer-related weight loss: no systematic reviews, intent-to-treat analysis yielded no difference between groups in appetite, quality of life, or toxicity</td>
<td>CONCLUSION 4-4: 4-4(a) There is limited evidence that cannabis and oral cannabinoids are effective in increasing appetite and decreasing weight loss associated with HIV/AIDS; 4-4(b) There is insufficient evidence to support or refute the conclusion that cannabinoids are an effective treatment for cancer-associated anorexia-cachexia syndrome and anorexia nervosa</td>
<td>Lutge et al. 2013; Whiting et al. 2015</td>
<td>Page 97</td>
</tr>
<tr>
<td>Irritable Bowl Syndrome (IBS)</td>
<td>No systematic reviews found. Single relevant trial (Wong et al. 2012) found no overall treatment effects based on 2 doses of dronabinol.</td>
<td>CONCLUSION 4-5 There is insufficient evidence to support or refute the conclusion that dronabinol is an effective treatment for the symptoms of irritable bowel syndrome.</td>
<td>None available</td>
<td>Page 99</td>
</tr>
<tr>
<td>Epilepsy</td>
<td>Two systematic reviews used. (Gloss &amp; Vickery 2014): identified 4 reports of randomized controlled trials that showed no reliable</td>
<td>CONCLUSION 4-6 There is insufficient evidence to support or refute the conclusion that cannabinoids are an effective treatment for</td>
<td>Gloss &amp; Vickery 2014; Koppel et al. 2014</td>
<td>Page 101</td>
</tr>
</tbody>
</table>

96
<table>
<thead>
<tr>
<th>Conditions</th>
<th>Systematic Review Summary</th>
<th>NASEM Conclusion</th>
<th>Sources</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spasticity Associated with Multiple Sclerosis and Paraplegia Caused by Spinal Cord Injury</td>
<td>Two systematic reviews used to determine association between cannabis use as effective treatment for spasticity associated with multiple sclerosis or spinal cord injury. Evidence from randomized controlled trials in review shows modest effect for MS patients but insufficient evidence to conclude cannabinoids effective for those with spasticity due to spinal cord injury.</td>
<td>CONCLUSION 4-7: 4-7(a) There is substantial evidence that oral cannabinoids are an effective treatment for improving patient-reported multiple sclerosis spasticity symptoms, but limited evidence for an effect on clinician-measured spasticity; 4-7(b) There is insufficient evidence to support or refute the conclusion that cannabinoids are an effective treatment for spasticity in patients with paralysis due to spinal cord</td>
<td>Koppel et al. 2014; Whiting et al. 2015</td>
<td>Page 101</td>
</tr>
<tr>
<td>Tourette Syndrome</td>
<td>Two systematic reviews used to determine association between cannabis use as effective treatment for symptoms associated with Tourette syndrome. No clear link established between the two.</td>
<td>CONCLUSION 4-8 There is limited evidence that THC capsules are an effective treatment for improving symptoms of Tourette syndrome.</td>
<td>Koppel et al. 2014; Whiting et al. 2015</td>
<td>Page 104</td>
</tr>
<tr>
<td>Amyotrophic Lateral Sclerosis (ALS)</td>
<td>No systematic reviews found to determine cannabis or cannabinoids as effective treatment for symptoms associated with ALS. Two small studies in the primary</td>
<td>CONCLUSION 4-9 There is insufficient evidence that cannabinoids are an effective treatment for symptoms associated with amyotrophic lateral sclerosis.</td>
<td>Koppel et al. 2014</td>
<td>Page 106</td>
</tr>
</tbody>
</table>
## THERAPEUTIC EFFECTS OF CANNABIS AND CANNABINOIDS

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Systematic Review Summary</th>
<th>NASEM Conclusion</th>
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<td>Huntington's Disease</td>
<td>Literature provide insufficient evidence to determine relationship.</td>
<td>CONCLUSION 4-10 There is insufficient evidence to support or refute the conclusion that oral cannabinoids are an effective treatment for chorea and certain neuropsychiatric symptoms associated with Huntington’s disease.</td>
<td>Koppel et al. 2014</td>
<td>107</td>
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<td>Parkinson's Disease</td>
<td>One systematic review was used to determine cannabis or cannabinoids as an effective treatment for the motor function and cognitive performance associated with Huntington’s disease. The two small studies in review show some potential benefits on chorea, but are lacking in many aspects so no determination can be made.</td>
<td>CONCLUSION 4-11 There is insufficient evidence that cannabinoids are an effective treatment for the motor system symptoms associated with Parkinson's disease or the levodopa-induced dyskinesia.</td>
<td>Koppel et al. 2014</td>
<td>110</td>
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<td>Dystonia</td>
<td>One systematic review was used to determine cannabis or cannabinoids as an effective treatment for dystonia. Two small trials failed to demonstrate significant benefit.</td>
<td>CONCLUSION 4-12 There is insufficient evidence to support or refute the conclusion that nabilone and dronabinol are an effective treatment for dystonia.</td>
<td>Koppel et al. 2014</td>
<td>111</td>
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<td>Dementia</td>
<td>Two systematic reviews were used to determine cannabis or cannabinoids as an effective treatment for symptoms associated with dementia. Authors of reviews determined no evidence that cannabinoids are effective in treating dementia.</td>
<td>CONCLUSION 4-13 There is limited evidence that cannabinoids are ineffective treatments for improving the symptoms associated with dementia.</td>
<td>Krishnan et al., 2009; van den Elsen et al. 2014</td>
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<td>Glaucoma</td>
<td>One systematic review was used to determine cannabis or cannabinoids as an effective treatment for glaucoma. Potential therapeutic benefit found, but quality of evidence limited.</td>
<td>CONCLUSION 4-14 There is limited evidence that cannabinoids are an ineffective treatment for improving intraocular pressure associated with glaucoma.</td>
<td>Whiting et al. 2015</td>
<td>Page 114</td>
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<tr>
<td>Traumatic Brain Injury/Intracranial Hemorrhage</td>
<td>One systematic review was used to determine cannabis or cannabinoids as an effective treatment or prevention for traumatic brain injury or intracranial hemorrhage. Two studies in review provide modest evidence that cannabis use might improve outcomes after TBI or ICH.</td>
<td>CONCLUSION 4-15 There is limited evidence of a statistical association between cannabinoids and better outcomes (i.e., mortality, disability) after a traumatic brain injury or intracranial hemorrhage.</td>
<td>None available</td>
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<td>Addiction</td>
<td>Two systematic reviews were used to determine cannabis or cannabinoids as an effective treatment for achieving abstinence from addictive substances. Neither of the two trials evaluated show significant effect.</td>
<td>CONCLUSION 4-16 There is no evidence to support or refute the conclusion that cannabinoids are an effective treatment for achieving abstinence in the use of addictive substances.</td>
<td>Marshall et al. 2014; Prud'Homme et al. 2015</td>
<td>Page 118</td>
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<td>Anxiety</td>
<td>One systematic review was used to determine cannabis or cannabinoids as an effective treatment for improvement of anxiety symptoms. Limited evidence shown improvement of anxiety symptoms with cannabidiol. However, there is moderate evidences that use increases anxiety symptoms and social phobia</td>
<td>CONCLUSION 4-17 There is limited evidence that cannabidiol is an effective treatment for the improvement of anxiety symptoms, as assessed by a public speaking test, in individuals with social anxiety disorders.</td>
<td>Whiting et al. 2015</td>
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<td>Depression</td>
<td>One systematic review was used to determine cannabis or cannabinoids as an effective treatment to reduce depressive symptoms. No effect shown with patients who have depressive disorders.</td>
<td>CONCLUSION 4-18 There is limited evidence that nabiximols, dronabinol, and nabilone are ineffective treatments for the reduction of depressive symptoms in individuals with chronic pain or multiple sclerosis.</td>
<td>Whiting et al. 2015</td>
<td>Page 121</td>
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<td>Sleep Disorders</td>
<td>One systematic review was used to determine cannabis or cannabinoids as an effective treatment for improving sleep outcomes. Moderate evidences suggests that cannabinoids can improve short term sleep outcomes. But no clinical trials to evaluate effects identified.</td>
<td>CONCLUSION 4-19 There is moderate evidence that cannabinoids, primarily nabiximols, are an effective treatment to improve short-term sleep outcomes in individuals with sleep disturbance associated with obstructive sleep apnea syndrome, fibromyalgia, chronic pain, and multiple sclerosis.</td>
<td>Whiting et al. 2015</td>
<td>Page 123</td>
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<td>Posttraumatic Stress Disorder (PTSD)</td>
<td>No systematic reviews were used to determine cannabis or cannabinoids as an effective treatment for PTSD symptoms. A single trial suggests potential benefits but has limited evidence.</td>
<td>CONCLUSION 4-20 There is limited evidence (a single, small fair-quality trial) that nabilone is effective for improving symptoms of posttraumatic stress disorder.</td>
<td>None available</td>
<td>Page 124</td>
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<td>Schizophrenia and Other Psychoses</td>
<td>Two systematic reviews were used to determine cannabis or cannabinoids as an effective treatment for the mental health outcomes of patients with schizophrenia or other psychoses. Two small trials were evaluated but provided only limited evidence and are</td>
<td>CONCLUSION 4-21 There is insufficient evidence to support or refute the conclusion that cannabidiol is an effective treatment for the mental health outcomes in individuals with schizophrenia or schizophreniform psychosis.</td>
<td>McLoughlin et al. 2014; Whiting et al. 2015</td>
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OTHER HEALTH EFFECTS: CONDITIONS BY CATEGORY

CANCERS

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<td>Lung Cancer</td>
<td>One quality systematic review was used to determine the association between cannabis use and the incidence of lung cancer. No statistically significant association between smoking cannabis and lung cancer is found. Studies reviewed note several limitations and thus additional evidence necessary to determine strong association.</td>
<td>CONCLUSION 5-1 There is moderate evidence of no statistical association between cannabis smoking and the incidence of lung cancer.</td>
<td>Zhang et al. 2015</td>
<td>Page 142</td>
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<td>Head and Neck Cancers</td>
<td>One quality systematic review was used to determine the association between cannabis use and the incidence of head and neck cancers. Individual studies show several limitations, but nonsignificant associations were observed for head and neck cancers. Risks that emerge over time are likely not detected in cohort studies done.</td>
<td>CONCLUSION 5-2 There is moderate evidence of no statistical association between cannabis use and the incidence of head and neck cancers.</td>
<td>de Carvalho et al. 2015</td>
<td>Page 144</td>
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<td>Testicular Cancer</td>
<td>One quality systematic review was used to determine the association between cannabis use and the incidence of testicular cancer.</td>
<td>CONCLUSION 5-3 There is limited evidence of a statistical association between current, frequent, or chronic cannabis smoking and non-seminoma-</td>
<td>Gurney et al. 2015</td>
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<td>Esophageal Cancer</td>
<td>A significant association found association between cannabis use and non-seminoma-type testicular germ cell tumors but not with seminoma-type germ cell tumors. Many limitations highlighted in this review.</td>
<td>CONCLUSION 5-4 There is insufficient evidence to support or refute a statistical association between cannabis smoking and the incidence of esophageal cancer.</td>
<td>None available</td>
<td>Page 148</td>
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<td>Other Cancers in Adults</td>
<td>No quality systematic reviews were found to determine the association between cannabis use and incidence of esophageal cancers. Primary literature discusses methodological issues of studies that do exist. No significant evidence to suggest association.</td>
<td>CONCLUSION 5-5 There is insufficient evidence to support or refute a statistical association between cannabis use and the incidence of prostate cancer, cervical cancer, malignant gliomas, non-Hodgkin lymphoma, penile cancer, anal cancer, Kaposi’s sarcoma, or bladder cancer.</td>
<td>None available</td>
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<td>Childhood Cancers</td>
<td>No quality systematic reviews were found to determine the association between parental cannabis use and the incidence of cancer in offspring. Primary literature findings were mixed, partly due to differences in methodology and design of studies.</td>
<td>CONCLUSION 5-6 There is insufficient evidence to support or refute a statistical association between parental cannabis use and a subsequent risk of developing acute myeloid leukemia/ acute non-lymphoblastic leukemia, acute lymphoblastic leukemia, acute myeloid leukemia.</td>
<td>None available</td>
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<td>Acute Myocardial Infarction</td>
<td>No quality systematic reviews were found to determine the association between cannabis use and acute myocardial infarction. Studies show that the role of cannabis as a trigger of AMI is plausible but also that there is no association with increased or decreased risk of AMI.</td>
<td>CONCLUSION 6-1: 6-1(a) There is limited evidence of a statistical association between cannabis smoking and the triggering of acute myocardial infarction; 6-1(b) There is no evidence to support or refute a statistical association between chronic effects of cannabis use and the risk of acute myocardial infarction.</td>
<td>None available</td>
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<td>Stroke</td>
<td>No quality systematic reviews were found to determine the association between cannabis use and stroke. All but two studies identified increase risk of stroke associated with cannabis, but they also indicated significant limitations. Other studies had conflicting data regarding different stroke types.</td>
<td>CONCLUSION 6-2 There is limited evidence of a statistical association between cannabis use and ischemic stroke or subarachnoid hemorrhage.</td>
<td>None available</td>
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<td>Metabolic Dysregulation, Metabolic Syndrome, Prediabetes, and Diabetes Mellitus</td>
<td>No quality systematic reviews were found to determine the association between cannabis use and metabolic dysregulation, metabolic syndrome, prediabetes, or diabetes mellitus. Three cross-sectional studies conducted for metabolic dysregulation and metabolic</td>
<td>CONCLUSION 6-3: 6-3(a) There is limited evidence of a statistical association between cannabis use and decreased risk of metabolic syndrome and diabetes; 6-3(b) There is limited evidence of a statistical association between cannabis use and increased risk of</td>
<td>None available</td>
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### THERAPEUTIC EFFECTS OF CANNABIS AND CANNABINOIDS

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<td>Prediabetes and diabetes examined.</td>
<td>Prediabetes and diabetes were both examined in one self-reported cannabis use study. Overall, cannabis use had either inverse association or no association with BMI, inverse associations with metabolic dysregulation and metabolic syndrome, and inverse or no association with diabetes mellitus. Only prediabetes showed increased risk, but results have limitations.</td>
<td>prediabetes.</td>
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### RESPIRATORY DISEASE

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<td>Pulmonary Function</td>
<td>One quality systematic review was used to determine the association between cannabis use and pulmonary function. Acute cannabis smoking was associated with bronchodilation but studies consistently said benefits could be offset with regular smoking. These findings are inconclusive for many measurements and there are significant limitations due to studies' controls and variability.</td>
<td>CONCLUSION 7-1: 7-1(a) There is moderate evidence of a statistical association between cannabis smoking and improved airway dynamics with acute use, but not with chronic use. 7-1(b) There is moderate evidence of a statistical association between cannabis smoking and higher forced vital capacity (FVC).</td>
<td>Tetrault et al. 2007</td>
<td>Page 186</td>
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<td>Chronic Obstructive Pulmonary Disease</td>
<td>No quality systematic reviews were found to determine the association between cannabis use and COPD. Potential issues with studies confounding effects of cannabis smoking with that of</td>
<td>CONCLUSION 7-2 (a) There is limited evidence of a statistical association between occasional cannabis smoking and an increased risk of developing chronic obstructive pulmonary disease (COPD)</td>
<td>None available</td>
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<td>Respiratory Symptoms, Including Chronic Bronchitis</td>
<td>Tobacco or other inhaled drugs. There is a lack of evidence between cannabis use and longitudinal lung function decline. The committee notes need for better studies to separate cannabis smoking from tobacco smoking on COPD risk and exacerbations.</td>
<td>When controlled for tobacco use. (b) There is insufficient evidence to support or refute a statistical association between cannabis smoking and hospital admissions for COPD.</td>
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<td>Asthma</td>
<td>One quality systematic review was used to determine the association between cannabis use and respiratory symptoms, including chronic bronchitis. This review looked at 14 studies and determined regular cannabis use associated with airway injury, worsening respiratory symptoms, and more frequent chronic bronchitis episodes.</td>
<td>CONCLUSION 7-3 (a) There is substantial evidence of a statistical association between long-term cannabis smoking and worse respiratory symptoms and more frequent chronic bronchitis episodes. (b) There is moderate evidence of a statistical association between cessation of cannabis smoking and improvements in respiratory symptoms.</td>
<td>Tetrault et al. 2007</td>
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### IMMUNITY

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<td>Immune Competence</td>
<td>No systematic review of quality to associate cannabis and immune competence in people without infectious diseases. Trend found in primary literature was</td>
<td>CONCLUSION 8-1 (a) There is limited evidence of a statistical association between cannabis smoking and a decrease in the production of several inflammatory</td>
<td>None available</td>
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### THERAPEUTIC EFFECTS OF CANNABIS AND CANNABINOIDS

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<td>Susceptibility to and Progression of Infectious Disease: HIV</td>
<td>Cannabis smoking related to decreased anti-inflammatory activity. But this was in contrast to results of cannabis having anti-inflammatory activity under certain conditions. The committee notes many limitations with studies.</td>
<td>Cytokines in healthy individuals. (b) There is insufficient evidence to support or refute a statistical association between cannabis smoking and other adverse immune cell responses in healthy individuals.</td>
<td>None available</td>
<td>Page 207</td>
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<tr>
<td>Susceptibility to and Progression of Infectious Disease: Viral Hepatitis C</td>
<td>No systematic review of quality to associate cannabis and immune status in people with HIV. Studies suggest cannabis does not adversely affect immune status of HIV patients.</td>
<td>CONCLUSION 8-2 There is insufficient evidence to support or refute a statistical association between cannabis or dronabinol use and adverse effects on immune status in individuals with HIV.</td>
<td>None available</td>
<td>Page 208</td>
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<td>Susceptibility to and Progression of Infectious Disease: HPV</td>
<td>No systematic review of quality to associate cannabis and susceptibility to oral HPV. Research available show conflicting results.</td>
<td>CONCLUSION 8-4 There is insufficient evidence to support or refute a statistical association between regular cannabis use and increased incidence of oral human papilloma virus (HPV).</td>
<td>None available</td>
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### INJURY AND DEATH

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<td>All-Cause Mortality</td>
<td>Two relevant studies as analyzed by single systematic review. No consistent statistically significant association found.</td>
<td>CONCLUSION 9-1 There is insufficient evidence to support or refute a statistical association between self-reported cannabis use and all-</td>
<td>Calabria et al. 2010</td>
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<td>Occupational Injury</td>
<td>No systematic review of quality to associate cannabis and occupational injury. Broad range of diverse studies with varying limitations and mixed results leads to no significant association.</td>
<td>CONCLUSION 9-2 There is insufficient evidence to support or refute a statistical association between general, nonmedical cannabis use and occupational accidents or injuries.</td>
<td>None available</td>
<td>Page 227</td>
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<td>Motor Vehicle Crashes</td>
<td>Six systematic reviews summarized association between driving under the influence of cannabis and motor vehicle crashes. These reviews find substantial evidence to support this association.</td>
<td>CONCLUSION 9-3 There is substantial evidence of a statistical association between cannabis use and increased risk of motor vehicle crashes.</td>
<td>Asbridge et al. 2012; Calabria et al. 2010; Elvik 2013; Hartman &amp; Huestis 2013; Li et al. 2012; Rogeberg &amp; Elvik 2016</td>
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<td>Overdose Injuries and Death</td>
<td>No systematic review of quality to associate cannabis and overdose injuries or death. Various studies cited that reported association of cannabis intoxication and death, but overall other studies show little evidence supports these claims. No case studies show cannabis consumption as direct cause of death. However many of these studies do express concern of other adverse effects, especially in terms of adolescent exposure.</td>
<td>CONCLUSION 9-4 (a) There is insufficient evidence to support or refute a statistical association between cannabis use and death due to cannabis overdose. (b) There is moderate evidence of a statistical association between cannabis use and increased risk of overdose injuries, including respiratory distress, among pediatric populations in U.S. states where cannabis is legal.</td>
<td>None available</td>
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<td>Pregnancy Complications for the Mother</td>
<td>No systematic review of quality to associate cannabis use and pregnancy complications for the Mother in the form of stillbirth or spontaneous abortion (miscarriage). But one systematic review for association of cannabis use and fetal distress based on two studies was reviewed. Report cautions interpretation of findings based on limitations of the studies reviewed.</td>
<td>CONCLUSION 10-1 There is limited evidence of a statistical association between maternal cannabis smoking and pregnancy complications for the mother.</td>
<td>Gunn et al. 2016</td>
<td>Page 249</td>
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<td>Fetal Growth and Development</td>
<td>One systematic review examined cannabis exposure on birth weight and found decreased birth weight, for cannabis-exposed infants, but no association between exposure and birth length, head circumference, intrauterine growth restriction, or congenital malformation.</td>
<td>CONCLUSION 10-2 There is substantial evidence of a statistical association between maternal cannabis smoking and lower birth weight of the offspring.</td>
<td>Gunn et al. 2016</td>
<td>Page 253</td>
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<td>Neonatal Conditions</td>
<td>One systematic review examined maternal cannabis use and neonatal conditions of the infant and found: decrease in gestational age and increased risk of NICU admission, but no other associations and discuss mixed findings for association of exposure and abnormal behavior.</td>
<td>CONCLUSION 10-3 There is limited evidence of a statistical association between maternal cannabis smoking and admission of the infant to the neonatal intensive care unit (NICU).</td>
<td>Gunn et al. 2016</td>
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<td>Later Outcomes</td>
<td>No systematic review of quality to associate maternal cannabis use and later outcomes of offspring. Three cohort studies analyzed for associations with SIDS, breastfeeding, physical growth, cognition/academic achievement, behavior, and mental health and psychosis. No support for effect of exposure on overall cognitive function found, but variation for specific associations discussed.</td>
<td>CONCLUSION 10-4 There is insufficient evidence to support or refute a statistical association between maternal cannabis smoking and later outcomes in the offspring (e.g., sudden infant death syndrome, cognition/academic achievement, and later substance use).</td>
<td>None available</td>
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## PSYCHOSOCIAL

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<td>Cognition</td>
<td>5 systematic reviews of literature within the three domains of cognition (memory, learning, and attention) are referenced. Learning: 3/5 reviews address cannabis use on learning. Memory: 3/5 reviews addressed cannabis use on memory. Attention: 4/5 reviews addressed cannabis use on attention. For all domains, immediate/short term effects were significant, but no long term associations were supported.</td>
<td>CONCLUSION 11-1 (a) There is moderate evidence of a statistical association between acute cannabis use and impairment in the cognitive domains of learning, memory, and attention. (b) There is limited evidence of a statistical association between sustained abstinence from cannabis use and impairments in the cognitive domains of learning, memory, and attention.</td>
<td>Batalla et al. 2013; Broyd et al. 2016; Grant et al. 2003; Martin-Santos et al. 2010; Schreiner &amp; Dunn 2012</td>
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<td>Academic Achievement</td>
<td>One systematic review examined effects of cannabis on psychosocial outcomes from data of 16 longitudinal studies with general</td>
<td>CONCLUSION 11-2 There is limited evidence of a statistical association between cannabis use and impaired academic achievement and education</td>
<td>Macleod et al. 2004</td>
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# THERAPEUTIC EFFECTS OF CANNABIS AND CANNABINOIDS

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<td>Employment and Income</td>
<td>No systematic review of quality to associate cannabis and employment and income. All conclusions based on primary literature and examined that cannabis use not statistically linked to employment.</td>
<td>CONCLUSION 11-3 There is limited evidence of a statistical association between cannabis use and increased rates of unemployment and/or low income.</td>
<td>None available</td>
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<td>Social Relationships and Other Social Roles</td>
<td>One systematic review examined effects of cannabis on social functioning and social roles through 16 longitudinal studies. Findings show inconsistency in cannabis use and social functioning behavior.</td>
<td>CONCLUSION 11-4 There is limited evidence of a statistical association between cannabis use and impaired social functioning or engagement in developmentally appropriate social roles.</td>
<td>Macleod et al. 2004</td>
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## MENTAL HEALTH

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<td>Schizophrenia and Other Psychoses</td>
<td>There were 5 systematic reviews that addressed association of cannabis use and development of schizophrenia or other psychoses. The findings from these reviews support a moderate to large association that is dose-dependent and potentially affected by genetics. One systematic review analyzed the association of cannabis use and the course or symptoms of schizophrenia or other.</td>
<td>CONCLUSION 12-1 There is substantial evidence of a statistical association between cannabis use and the development of schizophrenia or other psychoses, with the highest risk among the most frequent users. CONCLUSION 12-2 (a) There is moderate evidence that, among individuals with psychotic disorders, there is a statistical association between a history of cannabis use and better cognitive performance.</td>
<td>Donoghue &amp; Doody 2012; Large et al. 2011; Marconi et al. 2016; Moore et al. 2007; Myles et al. 2012; Rabin et al. 2011; Szoke et al. 2014; van der Meer et al. 2012; Yucel et al.</td>
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<td>Bipolar Disorder</td>
<td>One systematic review addressed the association between cannabis use and the development of bipolar disorder or mania. Some evidence supports the association between cannabis use and developing bipolar disorder, but mediators that could explain relationship unclear and could be affected by other factors. The same review was used to determine relationship between cannabis and the course or symptoms of bipolar disorder. Modest evidence was found, but adjustments for other substances were not made.</td>
<td>CONCLUSION 12-3 There is limited evidence of a statistical association between cannabis use and the likelihood of developing bipolar disorder, particularly among regular or daily users. CONCLUSION 12-4 There is moderate evidence of a statistical association between regular cannabis use and increased symptoms of mania and hypomania in individuals diagnosed with bipolar disorders.</td>
<td>Gibbs et al. 2015</td>
<td>Page 305</td>
</tr>
<tr>
<td>Depression</td>
<td>Two systematic reviews were identified to address the association between cannabis use and development of depressive disorders or symptoms. Evidence</td>
<td>CONCLUSION 12-5 There is moderate evidence of a statistical association between cannabis use and a small increased risk for the development of depressive</td>
<td>Lev-Ran et al. 2013; Moore et al. 2007</td>
<td>Page 310</td>
</tr>
</tbody>
</table>

- Psychoses and found limited significant effects on negative symptoms, cognition, and positive effects. 
- There is limited evidence of a statistical association between cannabis use and an increase in positive symptoms of schizophrenia (e.g., hallucinations) among individuals with psychotic disorders. 
- There is moderate evidence for no statistical association between cannabis use and worsening of negative symptoms of schizophrenia (e.g., blunted affect) among individuals with psychotic disorders.

(b) There is limited evidence of a statistical association between cannabis use and an increase in positive symptoms of schizophrenia (e.g., hallucinations) among individuals with psychotic disorders. 
(c) There is moderate evidence for no statistical association between cannabis use and worsening of negative symptoms of schizophrenia (e.g., blunted affect) among individuals with psychotic disorders.
## THERAPEUTIC EFFECTS OF CANNABIS AND CANNABINOIDS

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<tr>
<td>Suicide</td>
<td>suggests, from 10 longitudinal studies, a small increase in risk of developing the disorder. But no association was found in terms of the course or symptoms of depressive disorders.</td>
<td>CONCLUSION 12-6 There is no evidence to support or refute a statistical association between cannabis use and changes in the course or symptoms of depressive disorders.</td>
<td>Borges et al. 2016; Moore et al. 2007</td>
<td>Page 314</td>
</tr>
<tr>
<td>Anxiety</td>
<td>Two systematic reviews were identified to address the association between cannabis use and suicidal ideation, attempts, and suicide. Evidence suggests any cannabis use increases suicidal ideation, attempts, and risk of death by suicide and demonstrated a dose-response effect.</td>
<td>CONCLUSION 12-7 (a) There is moderate evidence of a statistical association between cannabis use and increased incidence of suicidal ideation and suicide attempts, with a higher incidence among heavier users. (b) There is moderate evidence of a statistical association between cannabis use and increased incidence of suicide completion.</td>
<td>Kedzior &amp; Laeber 2014</td>
<td>Page 318</td>
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</table>
## THERAPEUTIC EFFECTS OF CANNABIS AND CANNABINOIDS

| Conditions                                      | Systematic Review Summary                                                                                                                                                                                                 | NASEM Conclusion                                                                                                                                                                                                                                                                                                                                 | Sources     | Page  |
|------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------|
| Posttraumatic Stress Disorder (PTSD)           | No systematic review of quality to associate cannabis and the risk of developing PTSD. Additionally no significant primary literature was found to support this. In the case of association of course or symptoms of PTSD, primary explained a lack of data to make any conclusions of the relationship. | CONCLUSION 12-10 There is no evidence to support or refute a statistical association between cannabis use and the development of posttraumatic stress disorder. CONCLUSION 12-11 There is limited evidence of a statistical association between cannabis use and increased severity of posttraumatic stress disorder symptoms among individuals with posttraumatic stress disorder. | None available | Page 323 |

## PROBLEM CANNABIS USE

<p>| Conditions                                      | Systematic Review Summary                                                                                                                                                                                                 | NASEM Conclusion                                                                                                                                                                                                                                                                                                                                 | Sources     | Page  |
|------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------|
| Development of Problem Cannabis Use            | No systematic review of quality to associate cannabis and progression to developing problem cannabis use (cannabis abuse). Primary literature showed increasing cannabis use along with additional forms of cannabis consumption and claimed that these trends increase vulnerability to developing cannabis abuse tendencies. | CONCLUSION 13-1 There is substantial evidence for a statistical association between increases in cannabis use frequency and the progression to developing problem cannabis use.                                                                                                                                  | None available |       |</p>
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<tbody>
<tr>
<td>Risk and Protective Factors for Developing Problem Cannabis Use</td>
<td>The committee looked at anxiety, ADHD, Psychopathology, biological sex, other drug use, age of initiation of cannabis use, and other variables specific to adolescents. No quality reviews were found for these variables, but two pieces of primary literature support the suggestion that biological sex and age of initiation are positively associated with development of cannabis abuse.</td>
<td><strong>Anxiety and Depression</strong> 13-2(a) There is limited evidence that childhood anxiety and childhood depression are risk factors for the development of problem cannabis use. (b) There is moderate evidence that anxiety, personality disorders, and bipolar disorders are not risk factors for the development of problem cannabis use. (c) There is moderate evidence that major depressive disorder is a risk factor for the development of problem cannabis use. <strong>ADHD</strong> 13-2(d) There is moderate evidence that adolescent attention deficit hyperactivity disorder (ADHD) is not a risk factor for the development of problem cannabis use. (e) There is substantial evidence that stimulant treatment of ADHD during adolescence is not a risk factor for the development of problem cannabis use. Biological Sex (f) There is moderate evidence that being male is a risk factor for the development of problem cannabis use. <strong>Other Drug Use</strong> 13-2(g) There is moderate evidence that exposure to the combined use of abused drugs is a risk factor for the development of problem cannabis use. (h) There is moderate evidence that neither alcohol nor nicotine dependence alone are</td>
<td>Humphreys et al. 2013; Kedzior &amp; Laeber 2014</td>
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</table>
### Risk and Protective Factors for Severity and Persistence of Problem Cannabis Use

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<tr>
<td></td>
<td>No systematic review of quality to associate cannabis and the risk and protective factors for severity or persistence of problem cannabis use (cannabis abuse). Evidence shows risk factors include history of psychiatric treatment and being male as associated with cannabis abuse.</td>
<td>CONCLUSION 13-3 (a) There is moderate evidence of a statistical association between the persistence of problem cannabis use and a history of psychiatric treatment. (b) There is substantial evidence of a statistical association between being male and the severity of problem cannabis use, but the recurrence of problem cannabis use does not differ between males and females. (c) There is moderate evidence of a statistical association between problem</td>
<td>None available</td>
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### THERAPEUTIC EFFECTS OF CANNABIS AND CANNABINOIDS

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<tbody>
<tr>
<td>ABUSE OF OTHER SUBSTANCES</td>
<td>No systematic review of quality to associate cannabis and other substances reviewed including: tobacco/nicotine, opioids, and mixed drug use. Findings from primary literature</td>
<td>CONCLUSION 14-1 There is limited evidence of a statistical association between cannabis use and the initiation of tobacco use. CONCLUSION 14-2 There is limited evidence of a statistical association between cannabis use and changes in the rates and use patterns of other licit and illicit substances. CONCLUSION 14-3 There is moderate evidence of a statistical association between cannabis use and the development of substance dependence and/or a substance abuse disorder for substances, including alcohol, tobacco, and other illicit drugs. The development of problem cannabis use is described in Chapter 13 of this report.</td>
<td>None available</td>
<td>371</td>
</tr>
</tbody>
</table>

cannabis use and increased severity of posttraumatic stress disorder symptoms.
APPENDIX V: Monte Carlo Log File

Monte Carlo Analysis performed using Stata 15.

name: <unnamed>

log:
/Users/aribrown/Downloads/CBAFinal_MonteCarloAnalysis_MarijuanaGroup_Fall2018_FINAL.log

log type: text
opened on: 16 Dec 2018, 15:46:38

. // Discount Rate
. gen d1 = 1.017349
. gen d2 = 1.052957
. gen d3 = 1.089810
. gen d4 = 1.127954
. gen d5 = 1.167432
. forval i = 1/5 {
    2. la var d`i' "Discount denominator in year `i'"
    3. }

. // Population
. gen pop_initial = 5865519 + 14497*rnormal()
. gen pop_growth = .006 + .000588*rnormal()
. gen popy1 = pop_initial + (pop_growth*pop_initial)
. gen popy2 = pop_initial + (pop_growth*pop_initial) + (pop_growth*popy1)
. gen popy3 = pop_initial + (pop_growth*pop_initial) + (pop_growth*popy1) + (pop_growth*popy2)
. gen popy4 = pop_initial + (pop_growth*pop_initial) + (pop_growth*popy1) + (pop_growth*popy2) + (pop_growth*popy3)
. gen popy5 = pop_initial + (pop_growth*pop_initial) + (pop_growth*popy1) + (pop_growth*popy2) + (pop_growth*popy3) + (pop_growth*popy4)
.
. la var pop_initial "Initial population of Wisconsin"
. la var pop_growth "State avg. growth rate, year 1-5"
. la var popy1 "Wisconsin population, end Year 1"
. la var popy2 "Wisconsin population, end Year 2"
. la var popy3 "Wisconsin population, end Year 3"
. la var popy4 "Wisconsin population, end Year 4"
. la var popy5 "Wisconsin population, end Year 5"

. // User percentage of population
. gen user_pcty1t = (0.0026-.0001)/(0.007-.0001)
  . gen user_pcty1u = runiform()
  . gen user_pcty1 = .0001+sqrt(user_pcty1u*(.0026-.0001)*(.007-.0001)) if user_pcty1u < user_pcty1t
(6,342 missing values generated)
  . replace user_pcty1 = .007-sqrt((1-user_pcty1u)*(.007-.0026)*(.007-.0001)) if user_pcty1u > user_pcty1t
(6,342 real changes made)
. gen user_pcty2t = (0.0039-.0001)/(0.0098-.0001)
  . gen user_pcty2u = runiform()
  . gen user_pcty2 = .0001+sqrt(user_pcty2u*(0.0039-.0001)*(0.0098-.0001)) if user_pcty2u < user_pcty2t
(5,962 missing values generated)
  . replace user_pcty2 = .0098-sqrt((1-user_pcty2u)*(0.0098-.0039)*(0.0098-.0001)) if user_pcty2u > user_pcty2t
(5,962 real changes made)
. gen user_pcty3t = (0.0051-.0006)/(0.0129-.0006)
  . gen user_pcty3u = runiform()
  . gen user_pcty3 = .0006+sqrt(user_pcty3u*(0.0051-.0006)*(0.0129-.0006)) if user_pcty3u < user_pcty3t
(6,416 missing values generated)
  . replace user_pcty3 = .0129-sqrt((1-user_pcty3u)*(0.0129-.0051)*(0.0129-.0006)) if user_pcty3u > user_pcty3t
(6,416 real changes made)
. gen user_pcty4t = (0.0073-.0014)/(0.0166-.0014)
  . gen user_pcty4u = runiform()
  . gen user_pcty4 = .0014+sqrt(user_pcty4u*(0.0073-.0014)*(0.0166-.0014)) if user_pcty4u < user_pcty4t
(6,139 missing values generated)
  . replace user_pcty4 = .0166-sqrt((1-user_pcty4u)*(0.0166-.0073)*(0.0166-.0014)) if user_pcty4u > user_pcty4t
(6,139 real changes made)
. gen user_pcty5t = (0.0103-.0019)/(0.0218-.0019)
  . gen user_pcty5u = runiform()
  . gen user_pcty5 = .0019+sqrt(user_pcty5u*(0.0103-.0019)*(0.0218-.0019)) if user_pcty5u < user_pcty5t
(5,756 missing values generated)
replace user_pcty5 = .0218-sqrt((1-user_pcty5u)*(0.0218-.0103)*(0.0218-.0019)) if user_pcty5u > user_pcty5t
(5,756 real changes made)

la var user_pcty1 "User percentage, year 1"
la var user_pcty2 "User percentage, year 2"
la var user_pcty3 "User percentage, year 3"
la var user_pcty4 "User percentage, year 4"
la var user_pcty5 "User percentage, year 5"

//\\ //\\ **************************** BENEFITS
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
3. la var arrest_beny`i' "Reduction in arrest instances benefits in year `i''
4. }
   . gen arrest_ben_total = arrest_beny1 + arrest_beny2 + arrest_beny3 + arrest_beny4 + arrest_beny5
   . la var arrest_ben_total "Total arrest benefits"
   . forval i = 1/5 {
      2. gen justice_beny`i' = jail_beny`i' + court_beny`i' + arrest_beny`i'
      3. la var justice_beny`i' "Justice benefits in year `i' (decriminalization alternative only)"
   4. }
   . gen justice_ben_total = jail_ben_total + arrest_ben_total + court_ben_total
   . la var justice_ben_total "Total justice benefits (decriminalization alternative only)"
// Demand (both)
   . gen elasticity = runiform(-.79,-.67)
   . la var elasticity "Elasticity of demand for medicinal marijuana"
   . gen gram_price_t = (10.43 - 6.21)/(12.34 - 6.21)
   . gen gram_price_u = runiform()
   . gen gram_price = 6.21+sqrt(user_pcty1u*(10.43 - 6.21)*(12.34 - 6.21)) if user_pcty1u < user_pcty1t
   (6,342 missing values generated)
   . replace gram_price = 12.34-sqrt((1-user_pcty1u)*(12.34-10.43)*(12.34-6.21)) if user_pcty1u > user_pcty1t
   (6,342 real changes made)
   . la var gram_price "Avg. price per gram of medicinal marijuana"
   . gen quant_percapita = 191.4+29.96*rnormal()
   . la var quant_percapita "Annual quantity purchased per person"
   . forval i = 1/5 {
      2. gen quant_aggy`i' = (quant_percapita*user_pcty`i'*popy`i')/1000000
      3. la var quant_aggy`i' "Aggregate quantity in year `i' in millions of grams"
   4. }
   . forval i = 1/5 {
      2. gen slopey`i' = elasticity*(quant_aggy`i'/gram_price)
      3. la var slopey`i' "Demand slope for medicinal marijuana in year `i''"
   4. }
   . forval i = 1/5 {

2. gen intercepty`i' = quant_aggy`i' - (slopey`i'*gram_price)
3. la var intercepty`i' "Quant. intercept in year `i' in millions of grams"
4. }
. forval i = 1/5 {
2. gen choke_pricey`i' = (-intercepty`i')/slopey`i'
3. la var choke_pricey`i' "Choke price of medicinal marijuana in year `i'"
4. }
. forval i = 1/5 {
2. gen demand_beny`i' = (.5*(choke_pricey`i' - gram_price)*(quant_aggy`i')*1000000)/d`i'
3. la var demand_beny`i' "Demand benefits in year `i'"
4. }
. gen demand_ben_total = demand_beny1 + demand_beny2 + demand_beny3 + demand_beny4 + demand_beny5
. la var demand_ben_total "Total demand benefits"
. // Concentrates calculation (not used)
. gen concentrates_pct = runiform(.3937,.5173)
. gen market_multiplier = 1/(1-concentrates_pct)
. gen demand_ben_con = (demand_beny1 + demand_beny2 + demand_beny3 + demand_beny4 + demand_beny5)*market_multiplier
. la var demand_ben_con "Total demand benefits with concentrates"
. gen demand_con_only = demand_ben_con - demand_ben_total
. la var demand_con_only "Demand benefits from concentrates"
. // Opioid (both)
. gen opioid_b = .109
. gen opioid_c = .146
. gen opioid_d = runiform(.04,.06)
. gen opioid_e = runiform(.07,.09)
. gen opioid_f = runiform(.00168,.00252)
. gen opioid_g = runiform(.00294,.00378)
. gen opioid_h = 32286
. gen opioid_i = 1452499
. forval i = 1/5 {
2. gen opioid_beny`i' = (((user_pcty`i'*popy`i'*opioid_h)*((opioid_b*opioid_d)+(opioid_c*opioid_e))) + (((user_pcty`i'*popy`i'*opioid_i)*((opioid_b*opioid_f)+(opioid_c*opioid_g)))/d`i'
3. `la var opioid_beny`i' "Opioid benefits in year `i'''
4. }
. gen opioid_ben_total = opioid_beny1 + opioid_beny2 + opioid_beny3 + opioid_beny4 + opioid_beny5
. `la var opioid_ben_total "Total opioid benefits"
. gen addiction_pcty5 = (user_pcty5*popy5*opioid_b*opioid_d)+(user_pcty5*popy5*opioid_c*opioid_e)
. gen overdose_pcty5 = (user_pcty5*popy5*opioid_b*opioid_f)+(user_pcty5*popy5*opioid_c*opioid_g)
. // Fatal Car Accidents (both)
. gen vsl = 9600000
. `la var vsl "Value of a Statistical Life"
. gen fa_redux = .027 + .0133*rnormal()
. `la var fa_redux "% Decrease in Fatal Accidents"
. gen per_crash = 1.1
. `la var per_crash "Fatal Accidents per Crash"
. gen fa_num = runiform(404,496)
. `la var fa_num "Number of Fatal Accidents in Wisconsin"
. forval i = 1/5 {
 2. gen fa_beny`i' = (vsl*fa_redux*fa_num*per_crash)/d`i'
3. `la var fa_beny`i' "Fatal accident reduction benefits in year `i'''
4. }
. gen fa_ben_total = fa_beny1 + fa_beny2 + fa_beny3 + fa_beny4 + fa_beny5
. `la var fa_ben_total "Total fatal accident reduction benefits"
. // TOTAL
. forval i = 1/5 {
 2. gen benefits_y`i' = admin_beny`i' + justice_beny`i' + demand_beny`i' + opioid_beny`i' + fa_beny`i'
3. gen benefits_nd_y`i' = admin_beny`i' + demand_beny`i' + opioid_beny`i' + fa_beny`i'
4. `la var benefits_y`i' "Total benefits, non-discounted, decriminalization alternative, year `i'''
5. `la var benefits_nd_y`i' "Total benefits, non-discounted, non-decriminalization alternative, year `i'''
6. }
. gen benefits_total = benefits_y1 + benefits_y2 + benefits_y3 + benefits_y4 + benefits_y5
. gen benefits_nd_total = benefits_nd_y1 + benefits_nd_y2 + benefits_nd_y3 + benefits_nd_y4 + benefits_nd_y5
. la var benefits_total "Total benefits, decriminalization"
. la var benefits_nd_total "Total benefits, non-decriminalization"

. /// // Administrative (both)
. //gen admin_costs = 225000+(401800/d1)+(401800/d2)+(401800/d3)+(401800/d4)+(401800/d5)
. //la var admin_costs "Total administrative costs"
. // ER Visits - juvenile (both)
. forval i = 1/5 {
  2. gen k12pop_y`i' = (.1364*popy`i')/1000000
  3. la var k12pop_y`i' "Kids under age of 12 in Wisconsin, year `i'"
  4. }
. forval i = 1/5 {
  2. gen peder_by`i' = k12pop_y`i'*7.46
  3. la var peder_by`i' "Exposures treated in ED, no admission, year `i'"
  4. }
. forval i = 1/5 {
  2. gen peder_cy`i' = k12pop_y`i'*2.97
  3. la var peder_cy`i' "Annual exposures admitted, year `i'"
  4. }
. forval i = 1/5 {
  2. gen peder_dy`i' = k12pop_y`i'*1.76
  3. la var peder_dy`i' "Annual exposures critical care, year `i'"
  4. }
. forval i = 1/5 {
  2. gen ervisit_costs_y`i' = ((peder_by`i'*2424) + (peder_cy`i'*12207) + (peder_dy`i'*12207))/d`i'
  3. la var ervisit_costs_y`i' "Pediatric ER costs in year `i'"
  4. }
. gen ervisitcosts_total = ervisit_costs_y1 + ervisit_costs_y2 + ervisit_costs_y3 + ervisit_costs_y4 + ervisit_costs_y5
. la var ervisitcosts_total "Total cost of pediatric ER visit increase"
. // ER non-juvenile costs - DECRIMINALIZATION ONLY
forval i = 1/5 {
    2. gen decrim_er_costsy'i' = (.18786*popy'i')+d'i'
    3. la var decrim_er_costsy'i' "Non-juvenile ER costs in year `i'"
    4. }
    gen decrim_er_costs_total = decrim_er_costsy1 + decrim_er_costsy2 +
    decrim_er_costsy3 + decrim_er_costsy4 + decrim_er_costsy5
    la var decrim_er_costs_total "Total increased ER costs based on decriminalization"
. // Public Health Campaign (both)
gen ph_costs_yearly = 1500000+(4000000)*runiform()
la var ph_costs "Total costs of public health campaign"
. // TOTAL
    gen costs_nd_total = ervisitcosts_total /*+ admin_costs*/ + ph_costs
    gen costs_total = ervisitcosts_total /*+ admin_costs*/ + ph_costs +
    decrim_er_costs_total
    la var costs_total "Total costs, decriminalization"
    la var costs_nd_total "Total costs, non-decriminalization"
    /// ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~ FINAL CALCULATIONS
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
> // Decriminalization Alternative
    gen npv = (benefits_total - costs_total)/1000000
    la var npv "Net present value, decriminalization"
. // Non-Decriminalization Alternative
    gen npv_nd = (benefits_nd_total - costs_nd_total)/1000000
    la var npv_nd "Net present value, non-decriminalization"
gen sign = 1 if npv > 0
    replace sign = 0 if npv < 0
(0 real changes made)
    la var sign "Are there net benefits - decriminalization? 1 if yes"
gen sign Nd = 1 if npv_nd > 0
    replace sign Nd = 0 if npv_nd < 0
(0 real changes made)
    la var sign Nd "Are there net benefits - non-decriminalization? 1 if yes"
    /// ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~ VISUALIZATIONS
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
> hist npv, bin(50) frequency fcolor(forest_green) lcolor(black) ytitle(Number of trials) xtitle(Net present value in millions of dollars ($1,000,000)) /*
> */ title(Net Present Value of Decriminalization Alternative) subtitle(Positive in all trials)
(bin=50, start=38.258766, width=52.007408)

. hist npv_nd, bin(50) frequency fcolor(forest_green) lcolor(black) ytitle(Number of trials) xtitle(Net present value in millions of dollars ($1,000,000)) /*
> */ title(Net Present Value of Non-Decriminalization Alternative) subtitle(Positive in all trials)
(bin=50, start=6.4321241, width=51.978306)

. tab sign
  Are there | net | benefits - | decriminalization? 1 |
  if yes | Freq. Percent Cum. 
-----------------------------------
  1 | 10,000 100.00 100.00
-----------------------------------
  Total | 10,000 100.00

. tab sign_nd
  Are there | net | benefits - | non-decriminalization? 1 |
  if yes | Freq. Percent Cum. 
-----------------------------------
  1 | 10,000 100.00 100.00
-----------------------------------
  Total | 10,000 100.00
end of do-file
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