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CANNABIS IS NOT RISK FREE, BUT SMART POLICIES CAN REDUCE HARM

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EXECUTIVE SUMMARY

Since California legalized medical cannabis almost three decades ago, support for relaxed laws around the Schedule I substance has spread throughout the United States. More than three-fourths of states permit medical use, and more than one-third have legalized recreational adult consumption. As 91 percent of U.S. adults now support some degree of regulated legalization and politicians on both sides of the aisle are seeking federal decriminalization, this legislative trend is likely to continue.

Nonetheless, a number of national and community groups continue to speak out against cannabis legalization, voicing concerns about public health and safety. In this paper, we analyzed eight anti-cannabis efforts to identify several salient public health-related fears, assessed the validity of those claims and considered relevant implications for policy.

Our analysis of state and national efforts against cannabis legalization revealed five priority concerns: rising tetrahy-

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Figure 1: Colorado State Poison Control Center Call Data, 2000 to 2020 7

drocannabinol (THC) levels; the connection between cannabis use and mental health conditions; youth consumption; accidental poisonings, particularly among children; and the effect of cannabis intoxication on driving. In-depth reviews of the literature around each of these concerns showed that the issues tend to be highly nuanced. THC levels do appear to be higher than in the past, but this may be due to consumer preferences and market pressures, not exclusively or even primarily due to legalization. Cannabis consumption is linked to several mental health issues, but evidence on causal connections remains absent for some conditions and inconclusive for others. Legalizing cannabis for either medical or recreational adult consumption has not had any significant effect on past-30-day use among teens. Increased access to certain products that are more common in illicit markets—such as edibles—may be driving an increase in accidental consumption among children, but the overall numbers remain extremely low. And while THC likely does cause some driving impairment in most people, the extent of that impairment varies drastically from one person to another and is very difficult to assess.

These findings suggest that although cannabis is not risk free, most negative consequences can be mitigated through smart policy. As such, given the continuing trend toward legalization in the United States, we recommend several ways that federal, state and local entities can support harm-reducing approaches that will protect both consumer safety and autonomy across the country’s discrete, regulated cannabis markets.

Our policy recommendations include federal standards for and state regulation of dosing, potency and labeling; increased research and support for pilot programs to develop evidence-based strategies to assess cannabis-impaired driv-

ing; and continued support for youth-prevention efforts such as age minimums, compliance checks and targeted, fact-based prevention media.

This paper shows that although some of the concerns expressed by anti-legalization campaigns stem from the scientific literature, most reflect an incomplete picture and may be largely inaccurate. Cannabis' risks to public health and safety are manageable, and targeted and evidence-based policy can ensure safe, legal markets for medical and recreational use.

INTRODUCTION

In 1996, California became the first U.S. state to legalize medical cannabis. Since that time, cannabis laws have gradually relaxed throughout the country despite barriers resulting from the drug's federal Schedule I status. As of February 2022, 38 states and Washington, D.C. allow medical cannabis, and 18 states and Washington, D.C. permit recreational adult use.¹ That momentum is likely to continue: A 2021 survey found that 91 percent of U.S. adults supported legalizing medical cannabis, and 60 percent believed it should be legal for both medical and adult recreational consumption.² Already in 2022, legislatures and citizens in more than two dozen additional states have proposed legalizing and regulating recreational cannabis for adult consumption, and federal decriminalization is rapidly gaining traction among Republicans and Democrats alike.³

Despite growing support for cannabis legalization and regulation, efforts to loosen cannabis laws consistently meet with opposition from national- and state-level organizations. Communities and special interest groups raise concerns about a range of perceived public health and safety consequences of cannabis use and intoxication. Nonetheless, the legislative momentum is likely to persist. As such, to help states consider these issues through an evidence-based lens, this policy paper will:

- Identify and evaluate the validity of five primary health and safety concerns about cannabis use and intoxication with tetrahydrocannabinol (THC)—the primary compound responsible for the drug's

trademark “high”—commonly raised by opponents of legalization.

- Highlight relevant policy implications.

ASSESSING THE ARGUMENTS AGAINST LEGAL, REGULATED CANNABIS

To identify the primary concerns expressed by opponents of cannabis legalization and regulation, we conducted a qualitative discourse analysis of anti-cannabis efforts. Primary inclusion criteria were opposition to cannabis legalization legislation within the last five years and the presence of public-facing media. We coded multimedia campaigns, organization webpages and cannabis fact sheets using an inductive and multistep process. We used criteria of “frequency” (i.e., how often a particular concept appeared) and “intensity” (i.e., whether the concern was stressed visually or emotionally) to identify issues of highest priority to the anti-cannabis organization, limiting our analysis to those most relevant to public health.⁴ Due to the iterative nature of the process, we stopped recruiting new campaigns only when we had reached a saturation of relevant concerns. The final analysis included media output from eight organizations, four of which were national and four of which were state based and developed in direct opposition to state-specific legislation (Arizona, Michigan, Nevada and Vermont).⁵

Five substantial fears about the consequences of cannabis use and intoxication emerged as primary anti-legalization talking points at both national and state levels:

- Concern that THC levels appear to be higher than in the past
- Apprehension about a possible causal connection between cannabis use and mental health conditions
- Worry that youth use will increase
- Concern about accidental poisonings, particularly in children
- Worry about the consequences of cannabis intoxication on driving

In this section of the paper, we review the scientific literature on each of these issues. For each concern, we ask a key

1. Jeremy Berke et al., “Marijuana legalization is sweeping the US. See every state where cannabis is legal,” *Business Insider*, Feb. 23, 2022. <https://www.businessinsider.com/legal-marijuana-states-2018-1>.

2. Ted Van Green, “Americans overwhelmingly say marijuana should be legal for recreational or medical use,” Pew Research Center, April 16, 2021. <https://www.pewresearch.org/fact-tank/2021/04/16/americans-overwhelmingly-say-marijuana-should-be-legal-for-recreational-or-medical-use>.

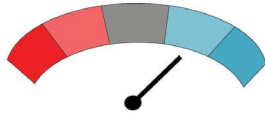
3. See, e.g., “2022 Cannabis Policy Reform Legislation,” Marijuana Policy Project, Feb. 17, 2022. <https://www.mpp.org/issues/legislation/key-marijuana-policy-reform>; Jennifer N. Le, “Federal Cannabis Reform – Is 2022 the Year?” *The National Law Review*, Feb. 11, 2022. <https://www.natlawreview.com/article/federal-cannabis-reform-2022-year>.

4. Sonja K. Foss, *Rhetorical Criticism: Exploration and Practice*, 4th ed. (Waveland Press, 2009).

5. Citizens Against Legalizing Marijuana, <https://calmca.org>; Michigan Department of Health & Human Services YouTube page, <https://www.youtube.com/c/MichiganHHS>; “D.A.R.E. America position paper on marijuana legalization,” D.A.R.E. America, Sept. 1, 2014. <https://dare.org/d-a-r-e-america-position-paper-on-marijuana-legalization>; “The impacts of marijuana legalization,” Drug Free America Foundation, Inc., Aug. 26, 2021. <https://www.dfaf.org/the-impacts-of-marijuana-legalization-know-the-truth>; Arizonans for Responsible Drug Policy, <https://arizonansforresponsibledrugpolicy.org>; Safe Montana, <https://wrongformontana.com>; Protecting Nevada’s Children, <https://www.facebook.com/VoteNoOn2NV>; Physicians, Families & Friends Educational Fund, <https://www.facebook.com/BetterVermont>.

question, provide a visual representation of the validity of the concern (a meter going from dark red, representing no/little validity to dark blue, representing complete validity), summarize our position on the question and then provide detailed evidence on how we arrived at that conclusion.

Are THC levels higher than they were in the past?



Maybe, but legalization is not the main driver.

Four of the eight campaigns we analyzed claimed that legal cannabis products have higher levels of THC than previously observed. And while these campaigns do not all explicitly blame legalization, they imply that higher-potency products will be a certain outcome of looser cannabis laws. Although it may be partially true that THC concentrations are higher than they once were, the reality behind this statement is nuanced.

A 2020 study of 8,505 cannabis products across 653 medical and recreational dispensaries in nine states found that legal cannabis came in a wide range of potencies, ranging from no THC to 45 percent THC.⁶ The average labeled THC concentration was about 20 percent, and the majority of products assessed reported a potency of greater than 15 percent.⁷ Another study found that cannabis flower sold in Washington state's legal retail shops averaged 20.6 percent THC, and extracts averaged 68.7 percent THC.⁸

These findings suggest that the cannabis sold on today's legal markets may contain substantially higher average THC concentrations than the illicit cannabis confiscated in the 1990s, which was more likely to have less than 5 percent THC.⁹

However, challenges in sampling from illegal markets and imperfections and inconsistencies in the methods used to test THC levels have led some experts to question whether these numbers are truly comparable.¹⁰ For example, govern-

ment samples tend to be tested using gas chromatography, whereas labs that test legal products often use liquid chromatography. Because the gas chromatography process heats the material being tested, it causes THC molecules to break down or change form.¹¹ Consequently, some in the field argue that this method underestimates true THC content compared to liquid chromatography.¹² As such, researchers may rely on product labels as accurate reflections of THC concentration without knowing what type of testing the product underwent.

In addition, if we focus on the illicit market, it becomes clear that the trend toward higher-potency cannabis is not strictly seen in the United States' nascent legal markets. Studies of product confiscated on the black market suggest that THC concentrations have been on the rise for more than 25 years.¹³ One study found that the mean concentration of THC in cannabis confiscated by the U.S. government in 2017 was 17.1 percent—higher than the 8.9 percent mean concentration estimated in 2008 and far closer to the potency of modern legal cannabis.¹⁴ Although research on cannabis potency preferences is limited, one study noted that the demand for high-potency formulations such as hashish and hash oil has been growing, and a handful of additional studies suggest that most people who purchase legal cannabis opt for high-THC flower despite the fact that the potency of smoked or vaporized products does not appear to affect subjective “highs.”¹⁵

Thus, evidence suggests that we may indeed be witnessing a trend toward more potent cannabis, both in terms of the strains being grown as well as the products being developed. Importantly, however, legalization does not appear to be the cause of this shift. Rather, the change appears to be driven by consumer preference and expectations.

6. Mary Catherine Cash et al., “Mapping cannabis potency in medical and recreational programs in the United States,” *PLoS One* 15:3 (March 2020). <https://doi.org/10.1371/journal.pone.0230167>.

7. Ibid.

8. Rosanna Smart et al., “Variation in cannabis potency and prices in a newly legal market: evidence from 30 million cannabis sales in Washington state,” *Addiction* 112 (December 2017), pp. 2167–2177. <https://onlinelibrary.wiley.com/doi/10.1111/add.13886>.

9. Mahmoud A. ElSohly et al., “Changes in cannabis potency over the last two decades (1995–2014) – analysis of current data in the United States,” *Biological Psychiatry* 79:7 (April 2016), pp. 613–619. <https://pubmed.ncbi.nlm.nih.gov/26903403>.

10. Adrienne LaFrance, “Was Marijuana Really Less Potent in the 1960s?,” *The Atlantic*, March 6, 2015. <https://www.theatlantic.com/technology/archive/2015/03/was-marijuana-really-less-potent-in-the-1960s/387010>.

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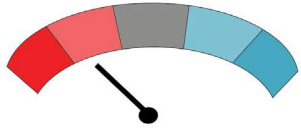
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13. ElSohly et al. <https://pubmed.ncbi.nlm.nih.gov/26903403>.

14. Suman Chandra et al., “New Trends in Cannabis Potency in USA and Europe During the Last Decade (2008–2017),” *European Archives of Psychiatry and Clinical Neuroscience* 269:1 (February 2019), pp. 5–15. <https://doi.org/10.1007/s00406-019-00983-5>.

15. ElSohly et al. <https://pubmed.ncbi.nlm.nih.gov/26903403>; Navin Kumar et al., “Cannabis Use Patterns at the Dawn of US Cannabis Reform,” *Journal of Cannabis Research* 1:5 (June 2019), p. 5. <https://icannabisresearch.biomedcentral.com/articles/10.1186/s42238-019-0003-z>; Yuyan Shi et al., “The Impacts of Potency, Warning Messages, and Price on Preferences for Cannabis Flower Products,” *International Journal of Drug Policy* 74 (December 2019), pp. 1–10. <https://www.sciencedirect.com/science/article/abs/pii/S0955395919302336?via%3Dihub>; L. Cinnamon Bidwell et al., “Association of Naturalistic Administration of Cannabis Flower and Concentrates With Intoxication and Impairment,” *JAMA Psychiatry* 77:8 (August 2020), pp. 787–796. <https://pubmed.ncbi.nlm.nih.gov/32520316>.

Does cannabis use cause mental health conditions?



Cannabis does not appear to increase the risk of most mental health conditions.

Disentangling cannabis' connection to mental health conditions is challenging. Evidence has correlated cannabis use with many mental health conditions; however, the specifics of the relationships are complex.¹⁶ Despite the undeniable evidence of an association, it is extremely difficult to establish causation—that is, whether or to what extent cannabis consumption causes mental health problems. An evaluation of the literature shows that there is no evidence of a causal connection between cannabis use and the development of most mental health conditions, with the possible exception of psychosis and schizophrenia.¹⁷

It is important to recognize that while there is strong evidence of correlation between cannabis use and the development of psychosis or schizophrenia, the evidence of a causal connection is emergent and limited and, as such, it is not definitive.¹⁸ The gold standard for demonstrating causality is a randomized controlled trial. However, because it would be unethical to expose people to cannabis for the purpose of determining whether they develop a mental health condition, researchers must use alternative methods. In this case, longitudinal and prospective cohort study designs have been used to examine whether cannabis use precedes the onset of schizophrenia or psychosis.¹⁹ In addition, genome-wide

association analyses have been used to look for genetic markers for schizophrenia and cannabis use.²⁰ One such study found that people who used cannabis had an increased risk of developing schizophrenia, which suggested a causal connection.²¹ Although there is likely a shared genetic predisposition to cannabis use and psychosis, it is unclear whether this trait makes people both more likely to use cannabis and more vulnerable to psychosis or whether people with this trait can prevent the onset of psychosis by avoiding cannabis use.²² Thus, while there is growing evidence that cannabis use often precedes and may sometimes contribute to schizophrenia or psychosis, this does not mean that every person who uses cannabis is susceptible to developing these conditions due to cannabis use.²³

Beyond psychosis and schizophrenia, research does show correlations between cannabis consumption and symptoms of or diagnosis with major depressive disorder (MDD), bipolar disorder, suicidality and anxiety disorders.²⁴ However, the evidence is not strong enough to determine whether the correlation is because cannabis use contributes to the development of these issues or because individuals who are predisposed to these issues are also likely to use cannabis

16. Shaul Lev-Ran et al., "Cannabis use and cannabis use Disorders among individuals with mental illness," *Comprehensive Psychiatry* 54:6 (August 2013), pp. 589-598. <https://www.sciencedirect.com/science/article/pii/S0010440X13000187>.

17. Aliya M. Lucatch et al., "Cannabis and Mood Disorders," *Current Addiction Reports* 5:3 (September 2018), pp. 336-345. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6329464>; National Academies of Sciences, Engineering, and Medicine, *The Health Effects of Cannabis and Cannabinoids: The Current State of Evidence and Recommendations for Research* (National Academies Press, Jan. 12, 2017), pp. 289-332. <https://www.ncbi.nlm.nih.gov/books/NBK425748>.

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19. P. Allebeck et al., "Cannabis and schizophrenia: a longitudinal study of cases treated in Stockholm County," *Acta Psychiatrica Scandinavica* 88:1 (July 1993), pp. 21-24. <https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1600-0447.1993.tb03408.x>; John McGrath et al., "Association Between Cannabis Use and Psychosis-Related Outcomes Using Sibling Pair Analysis in a Cohort of Young Adults," *Archives of General Psychiatry* 67:5 (May 2010), pp. 440-447. <https://jamanetwork.com/journals/jamapsychiatry/article-abstract/210748>.

20. Urits et al. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7255842>.

21. J. Vaucher et al., "Cannabis use and risk of schizophrenia: a Mendelian randomization study," *Molecular Psychiatry* 23:5 (May 2018), pp. 1287-1292. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5984096>.

22. Urits et al. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7255842>; Johns, <https://www.cambridge.org/core/journals/the-british-journal-of-psychiatry/article/psychiatric-effects-of-cannabis/08CDBE0BE6E53A59BE52538D810E9B0>; Robin M. Murray et al., "Traditional marijuana, high-potency cannabis and synthetic cannabinoids: increasing risk for psychosis," *World Psychiatry* 15:3 (October 2016), pp. 195-204. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5032490>.

23. Thomas H. Richardson, "Cannabis Use and Mental Health: A Review of Recent Epidemiological Evidence," *International Journal of Pharmacology* 6:6 (June 2010), pp. 796-807. https://www.researchgate.net/profile/Thomas-Richardson-2/publication/49595223_Cannabis_Use_and_Mental_Health_A_Review_of_Recent_Epidemiological_Research/links/0f3175345815e0e136000000/Cannabis-Use-and-Mental-Health-A-Review-of-Recent-Epidemiological-Research.pdf.

24. National Academies of Sciences, Engineering, and Medicine, <https://www.ncbi.nlm.nih.gov/books/NBK425748>; Richardson, https://www.researchgate.net/profile/Thomas-Richardson-2/publication/49595223_Cannabis_Use_and_Mental_Health_A_Review_of_Recent_Epidemiological_Research/links/0f3175345815e0e136000000/Cannabis-Use-and-Mental-Health-A-Review-of-Recent-Epidemiological-Research.pdf; Lucatch et al. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6329464>; S. Lev-Ran and D. Feingold, "Cannabis use and its association to mental illness: A focus on mood and anxiety disorders," In V.R. Preedy, ed., *Handbook of Cannabis and Related Pathologies: Biology, Pharmacology, Diagnosis, and Treatment* (Elsevier Academic Press, 2017), pp. 298-307. <https://psycnet.apa.org/record/2017-28924-028>; Darby J.E. Lowe et al., "Cannabis and Mental Illness: A Review," *European Archives of Psychiatry and Clinical Neuroscience* 269:1 (February 2019), pp. 107-120. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6397076>; George and Vaccarino, eds. https://www.researchgate.net/profile/Joanna-Henderson-2/publication/278963847_The_Effects_of_Cannabis_Use_during_Adolescence/links/5588192808ae65ae5a4e1811/The-Effects-of-Cannabis-Use-during-Adolescence.pdf#page=36; Gabriella Gobbi et al., "Association of Cannabis Use in Adolescence and Risk of Depression, Anxiety, and Suicidality in Young Adulthood: A Systematic Review and Meta-analysis," *JAMA Psychiatry* 76:4 (April 1, 2019), pp. 426-434. <https://jamanetwork.com/journals/jamapsychiatry/fullarticle/2723657>; Urits et al. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7255842>.

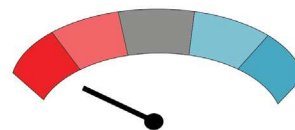
either recreationally or to self-medicate.²⁵ Thus, more research is needed to understand the nature of the relationship between mental health and cannabis use.

Importantly, with some of these conditions—MDD, suicidality, psychosis and schizophrenia—there is evidence of a dose-response effect.²⁶ This means that people who use cannabis more frequently have a higher likelihood of developing these conditions.²⁷ Earlier age of onset of cannabis use is another risk factor for developing MDD, psychosis or schizophrenia and has been associated with a more severe and earlier onset of systems of psychosis.²⁸ Finally, some research suggests that using strains of cannabis that are high in THC and low in CBD increases the risk of developing schizophrenia.²⁹

In reviewing the literature, it is clear that the relationship between cannabis and mental health is complicated, with a variety of social, environmental and even genetic factors at play. While cannabis use is correlated with a number of

mental health issues, it does not appear to be either necessary or sufficient to cause any of them. In the case of schizophrenia and psychosis, evidence suggests that cannabis use—especially of high-THC/low-CBD products beginning at a young age—may be a contributing factor but is unlikely to be the sole or even a primary cause.

Are teens consuming more cannabis?



Cannabis legalization does not increase youth use.

Fear that cannabis legalization will lead to increased use among youth dominates the opposition discourse. Every campaign and website in our analysis focused on the dangers that cannabis consumption presents to young people—and rightfully so, as there is broad consensus that cannabis consumption is risky for developing brains.³⁰ In fact, all of the states that have legalized recreational cannabis only permit sales to individuals 21 years of age or older.³¹

Despite this worry, national and representative state data both show that youth use has not been negatively affected by the decriminalization of cannabis, the legalization of medical cannabis or the legalization of regulated adult recreational consumption.³² The Monitoring the Future survey revealed that nationwide rates of teen cannabis use (as of February 2022) have declined slightly since the late 1990s and have remained fairly stable since 2005.³³ At the state level, a quasi-experimental study of the effects of cannabis policy on youth use drawn from state Youth Risk Behavior Surveys found that the implementation of medical cannabis policies was followed by reductions in the percentage of teens who reported current use, with the change being especially pronounced among Black and Hispanic youth.³⁴ In Colorado, state-representative surveys indicated that lifetime and past-

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30. Kirsten Weir, “Marijuana and the developing brain,” *Monitor on Psychology*, American Psychological Association, 46:10 (November 2015). <https://www.apa.org/monitor/2015/11/marijuana-brain>.

31. “Marijuana Laws by State,” The Insurance Institute for Highway Safety and the Highway Loss Data Institute, March 2022. <https://www.iihs.org/topics/alcohol-and-drugs/marijuana-laws-table>.

32. Lloyd D. Johnston et al., “Marijuana: Trends in 30 Day Prevalence of Use in 8th, 10th, and 12th Grade,” *Monitoring the Future: National Survey Results on Drug Use 1975-2021*, The National Institute on Drug Abuse at The National Institutes of Health, 2022. http://monitoringthefuture.org/data/21data/MJ/MJ_jsFigures.htm; Rebekah Levine Coley et al., “A quasi-experimental evaluation of marijuana policies and youth marijuana use,” *The American Journal of Drug and Alcohol Abuse* 45:3 (Feb. 15, 2019), pp. 292-303. <https://www.tandfonline.com/doi/full/10.1080/00952990.2018.1559847>.

33. Johnston et al. http://monitoringthefuture.org/data/21data/MJ/MJ_jsFigures.htm.

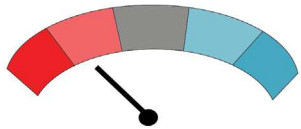
34. Coley et al. <https://www.tandfonline.com/doi/full/10.1080/00952990.2018.1559847>.

30-day cannabis use among high school students was unaffected by recreational legalization, but frequent use and use on school property declined among current users.³⁵ Similarly, following legalization, the Washington Healthy Youth Survey showed declines in past-month cannabis use among eighth and 10th graders and no change among 12th graders.³⁶

While promising, these findings do not mean that youth are unaffected by legalization. Researchers will need to study how differences in the restrictiveness of local policies might affect use. Some evidence suggests that although legal markets do not increase teen use rates, they may affect teen consumption patterns. For example, one study found that teens living in states where cannabis is legal are more likely to use edibles and THC vape products than their counterparts in states with no legal market—a pattern that is consistent with both a health-oriented transition away from combustible cigarettes and a preference for discreet, easy-to-consume products.³⁷

As use patterns change, new questions will likely emerge for public health experts to explore. However, current data suggest that neither the legalization of medical cannabis nor adult recreational use inherently leads to increased youth consumption.

Are accidental cannabis poisonings a danger to children?



Accidental consumption is rising, but it remains rare.

Another claim made by many of the anti-cannabis campaigns is that accidental poisonings from cannabis are increasing. Most of the messages argue that colorful labels, insufficient warnings about THC contents, and products that resemble ordinary, familiar foods and drinks may confuse or entice children, resulting in accidental consumption. Indeed, there are many case reports of children and adults presenting to the hospital with acute cannabis toxicity. Unfortunately, there are fewer population-level studies assessing the rate of accidental cannabis poisonings.

35. Ashley Brooks-Russell et al., "Adolescent Marijuana Use, Marijuana-Related Perceptions, and Use of Other Substances Before and After Initiation of Retail Marijuana Sales in Colorado (2013-2015)," *Prevention Science* 20:2 (February 2019), pp. 185-193. <https://link.springer.com/article/10.1007/s11121-018-0933-2>.

36. Julia A. Dilley et al., "Prevalence of Cannabis Use in Youths After Legalization in Washington State," *JAMA Pediatrics* 173:2 (Dec. 19, 2018), pp. 192-193. <https://jamanetwork.com/journals/jamapediatrics/fullarticle/2718512>.

37. Jacob T. Borodovsky et al., "U.S. cannabis legalization and use of vaping and edible products among youth," *Drug and Alcohol Dependence* 177 (Aug. 1, 2017), pp. 299-306. <https://pubmed.ncbi.nlm.nih.gov/28662974>.

Most of the research that does exist relies on data from poison control centers or hospital admissions. The 2016 Nationwide Emergency Department Sample (NEDS) estimated that 16,884 people in the United States ages 12 and older were admitted to emergency departments under the International Classification of Diseases diagnostic code for cannabis poisoning, accounting for 0.014 percent of total admissions.³⁸ Young people (ages 12 to 17) had a higher risk of being admitted to the emergency department for cannabis poisoning than those who were 30 years and older, and people admitted to the emergency department for cannabis poisoning were more likely to be uninsured, experiencing housing or economic adversity and residing in central cities compared to people admitted for other causes.³⁹ Finally, it is important to note that many of the people admitted to the emergency department under the cannabis poisoning diagnostic code had additional diagnostic codes for accidental poisoning with other substances.⁴⁰ For this subset of individuals, it is impossible to determine whether the emergency department admission was precipitated by the consumption of cannabis or another substance, suggesting that the number of cannabis-related admissions could be somewhat inflated.

Despite these limitations, some studies have sought to directly examine whether accidental cannabis exposures increase in the wake of medical or recreational legalization.⁴¹ For example, data from the National Poison Data System show extremely few annual calls for accidental cannabis exposure—just 496 in states where cannabis was not legal and 396 in states where it was decriminalized.⁴² The data also showed that the call rate increased only in states where cannabis was decriminalized.⁴³ While this could indicate that looser laws lead to an increase in accidental exposures, it could also be a sign that decriminalization and legalization cause people to be less afraid of reporting these incidents.

A closer examination of data from individual states supports these overall trends but indicates that details may differ substantially from one jurisdiction to the next. In Massachusetts, the incidence of cannabis-related calls to the regional poison control center increased from 0.4 per 100,000 residents ages 0 to 19 before the legalization of medicinal cannabis in 2012

38. Christopher P. Salas-Wright et al., "Prevalence and correlates of cannabis poisoning diagnosis in a National Emergency Department Sample," *Drug and Alcohol Dependence* 204 (Nov. 1, 2019). <https://pubmed.ncbi.nlm.nih.gov/31568933>.

39. Ibid.

40. Ibid.

41. Jasleen K. Grewal and Lawrence C. Loh, "Health Considerations of the Legalization of Cannabis Edibles," *Canadian Medical Association Journal* 192:1 (Jan. 6, 2020), pp. E1-E2. <https://www.cmaj.ca/content/192/1/E1.short>.

42. George S. Wang et al., "Association of unintentional pediatric exposures with decriminalization of marijuana in the United States," *Annals of Emergency Medicine* 63:6 (June 2014), pp. 684-689. <https://pubmed.ncbi.nlm.nih.gov/24507243>.

43. Ibid.

FIGURE 1: COLORADO STATE POISON CONTROL CENTER CALL DATA, 2000 TO 2020

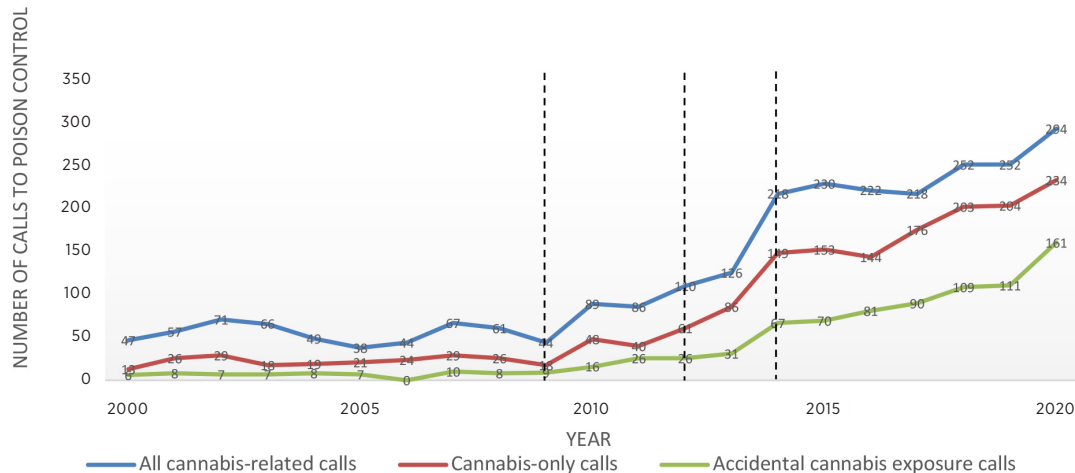


Figure 1: Cannabis-related call data from Colorado Poison Control, also known as Rocky Mountain Poison and Drug Safety. The vertical, dotted lines indicate years when key policy was passed or implemented to expand legal access to cannabis. In 2009, medical dispensaries were permitted; in 2012, voters legalized recreational use for adults 21 and older; in 2014, the state opened its first recreational retail establishments.

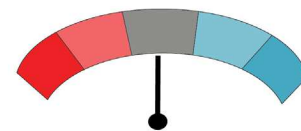
Source: Rocky Mountain Poison and Drug Safety, “Marijuana Exposures Reported to Colorado Poison Center,” Colorado Department of Public Health and Environment, 2022. <https://marijuanahealthinfo.colorado.gov/health-data/poison-center-data>.

to 1.1 per 100,000 residents after its legalization.⁴⁴ In Colorado, significant increases were seen in cannabis-related calls to the state’s poison center following the widespread opening of medical and recreational dispensaries (Figure 1).⁴⁵ Interestingly, Colorado calls involved substantially younger children than Massachusetts calls—averaging two years old according to one study versus a majority of Massachusetts calls involving those ages 15 to 19 years.⁴⁶ Furthermore, in Colorado, poison center calls mentioning cannabis consumption stabilized somewhat after initial policy-related spikes, although the upward trend returned from 2018 to 2020.⁴⁷

Taken together, these data show that accidental exposures to cannabis are increasing, especially among children. However, the absolute number of exposures is still quite low. One study, for example, estimated the exposure rate to be

5.9 per one million children in the United States.⁴⁸ Additionally, evidence from Colorado suggests that there may be an initial increase in cases of accidental exposure to cannabis after legalization; however, this increase may level off after a short period.⁴⁹

Is driving “high” causing more accidents and road fatalities?



THC-related driving impairment is highly variable and challenging to assess.

Nearly all of the opposition campaigns analyzed implicated cannabis in a growing number of vehicle accidents and traffic fatalities, often via powerful imagery depicting mangled cars and devastated families.

Epidemiologic data clearly support the claim that the number of drivers on the road with THC in their bloodstream has increased in recent years. One nationwide study found that the percentage of weekend nighttime drivers who tested positive for THC rose from 8.6 percent in 2007 to 12.6

44. Reed. https://cdpsdocs.state.co.us/ors/docs/reports/2018-SB13-283_Rpt.pdf.

45. Jonathan M. Davis et al., “Public Health Effects of Medical Marijuana Legalization in Colorado,” *American Journal of Preventive Medicine*, 50:3, (March, 2016), pp. 373-379. <https://www.sciencedirect.com/science/article/abs/pii/S0749379715004006>; Rocky Mountain Poison and Drug Safety, “Marijuana Exposures Reported to Colorado Poison Center,” Colorado Department of Public Health and Environment, 2022. <https://marijuanahealthinfo.colorado.gov/health-data/poison-center-data>.

46. Jennifer M. Whitehill et al., “Incidence of Pediatric Cannabis Exposure Among Children and Teenagers Aged 0 to 19 Years Before and After Medical Marijuana Legalization in Massachusetts,” *JAMA Network Open* 2:8 (Aug. 2, 2019), 1-10. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6704738>; George Sam Wang et al., “Unintentional Pediatric Exposures to Marijuana in Colorado, 2009-2015,” *JAMA Pediatrics* 107:9 (Sept. 6, 2016). <https://jamanetwork.com/journals/jamapediatrics/fullarticle/2534480>.

47. Jack K. Reed, “Impacts of Marijuana Legalization in Colorado: A Report Pursuant to Senate Bill 13-283,” Colorado Department of Public Safety, Division of Criminal Justice, Office of Research and Statistics, October 2018. https://cdpsdocs.state.co.us/ors/docs/reports/2018-SB13-283_Rpt.pdf; Rocky Mountain Poison and Drug Safety. <https://marijuanahealthinfo.colorado.gov/health-data/poison-center-data>.

48. Bridget Onders et al., “Marijuana Exposure Among Children Younger Than Six Years in the United States,” *Clinical Pediatrics* 55:5 (May 2016), pp. 428-436. <https://pubmed.ncbi.nlm.nih.gov/26054783>.

49. Reed. https://cdpsdocs.state.co.us/ors/docs/reports/2018-SB13-283_Rpt.pdf.

percent between 2013 and 2014.⁵⁰ Similarly, in another study, researchers saw a significant increase in the percentage of Washington state drivers involved in fatal crashes who tested positive for THC, from 8.8 percent in 2012 (before legalization) to 21.4 percent in 2017 (after legalization of adult recreational use).⁵¹ It is important to note, however, that these increases do not necessarily indicate that cannabis impairment is causing more accidents. Rather, they are consistent with the fact that cannabis use rates are increasing among adults, and if a greater proportion of people are consuming cannabis, it can be expected that a greater proportion of those individuals will be on the road and involved in traffic accidents, including those with fatal outcomes.⁵² Thus, it is important to consider research that looks specifically at crash risk and driving impairment.

Several global meta-analyses have found that cannabis use does increase one's odds of a motor vehicle accident, although estimates of the degree to which that risk is increased are mixed. For example, one study found that cannabis use more than doubled the likelihood of a crash, whereas other studies found risk to be increased by 20 to 40 percent, which is akin to a blood alcohol content (BAC) of 0.04 to 0.05.⁵³ Again, while these studies suggest that there is a relationship between cannabis consumption and impaired driving, they do not prove causation.

Several recent studies have considered the question of causation by directly examining the impact of cannabis consumption on driving using a variety of experimental designs and a mix of real-life consumption scenarios, driving simulators and controlled road tests. Overall, this research indicates that THC intoxication does lead to modest, statistically

significant driving impairment. The degree of impairment is similar to that seen with a BAC of 0.05.⁵⁴

Another factor to consider is that the relationship between blood THC levels and driving performance or recent cannabis smoking history is neither linear nor consistent. For example, one study found that only about half of participants who displayed impaired driving also tested positive above typical *per se* cutoff limits.⁵⁵ In addition, a substantial number tested above the *per se* limit but drove without impairment (false positive), and others were clearly impaired, but their blood THC levels remained below the *per se* limits (false negative). Furthermore, this same study found that the subjective experience of being "high" was not correlated with the ability to drive; some participants evaluated themselves as unimpaired when, in fact, their driving ability was diminished.⁵⁶ Similarly, a randomized controlled trial found that THC consumption did impair driving, but there was poor correlation between driving performance and blood THC levels or subjective experience of intoxication.⁵⁷

These inconsistencies have several possible explanations. First, it is well established that regular cannabis consumers may have low levels of THC in their blood even when they haven't used cannabis in days or weeks.⁵⁸ Second, individuals who consume cannabis on a regular basis develop tolerance, which in some cases may reduce the degree to which THC affects their psychomotor abilities (although it is not clear whether that tolerance is significantly or consistently protective against impairment).⁵⁹ Third, although blood THC levels spike shortly after smoking, the effects on attention and motor skills have been shown to linger for as long as eight hours for some individuals, a factor that may be affected by developed tolerance.⁶⁰ Finally, different modes of consumption add even more variation to how cannabis is metabolized,

50. Richard P. Compton and Amy Berning, "Drug and Alcohol Crash Risk Study: Research Note," U.S. Department of Transportation, National Highway Traffic Safety Administration, February 2015, p. 3. <https://www.nhtsa.gov/behavioral-research/drug-and-alcohol-crash-risk-study>.

51. B.C. Tefft and L.S. Arnold, "Cannabis Use Among Drivers in Fatal Crashes in Washington State Before and After Legalization (Research Brief)," AAA Foundation for Traffic Safety, 2020. <https://aaaafoundation.org/cannabis-use-among-drivers-in-fatal-crashes-in-washington-state-before-and-after-legalization>.

52. "Key substance use and mental health indicators in the United States: Results from the 2020 National Survey on Drug Use and Health," Substance Abuse and Mental Health Services Administration, Health and Human Services, 2020. <https://www.samhsa.gov/data/report/2020-nsduh-annual-national-report>.

53. Mu-Chen Li et al., "Marijuana Use and Motor Vehicle Crashes," *Epidemiological Reviews* 34:1 (January 2012), pp. 65-72. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3276316/>; Rune Elvik, "Risk of road accident associated with the use of drugs: A systematic review and meta-analysis of evidence from epidemiological studies," *Accident Analysis and Prevention* 60 (November 2013), pp. 254-267. <https://www.sciencedirect.com/science/article/abs/pii/S0001457512002412>; Ole Rogeberg and Rune Elvik, "The effects of cannabis intoxication on motor vehicle collision revisited and revised," *Addiction* 111:8 (August 2016), pp. 1348-1359. <https://pubmed.ncbi.nlm.nih.gov/26878835>.

54. Sarah Hartley et al., "Risk Using Simulated Driving in Occasional and Chronic Users and the Pharmacokinetic-Pharmacodynamic Relationship," *Clinical Chemistry* 65:5 (May 2019), pp. 684-693. <https://pubmed.ncbi.nlm.nih.gov/30872375/>; Ashley Brooks-Russell et al., "Simulated driving performance among daily and occasional cannabis users," *Accident Analysis and Prevention* 160 (September 2021). <https://www.sciencedirect.com/science/article/abs/pii/S0001457521003572?via%3Dihub>.

55. Thomas R. Arkell et al., "The failings of per se limits to detect cannabis-induced driving impairment: Results from a simulated driving study," *Traffic Injury Prevention* 22:2 (Feb. 5, 2021), pp. 102-107. <https://www.tandfonline.com/doi/full/10.1080/15389588.2020.1851685>.

56. Ibid.

57. Thomas D. Marcotte et al., "Driving Performance and Cannabis Users' Perception of Safety: A Randomized Clinical Trial," *JAMA Psychiatry* (Jan. 26, 2022), pp. 201-209. <https://jamanetwork.com/journals/jamapsychiatry/article-abstract/2788264>.

58. Arkell et al. <https://www.tandfonline.com/doi/full/10.1080/15389588.2020.1851685>.

59. Brooks-Russell et al. <https://www.sciencedirect.com/science/article/abs/pii/S0001457521003572?via%3Dihub>.

60. Hartley et al. <https://pubmed.ncbi.nlm.nih.gov/30872375>.

which has important implications for both impairment and testing.⁶¹

These distinct areas of research collectively suggest that cannabis use likely impairs driving for many people but that our understanding of the degree of impairment and our ability to measure it are lacking. As such, to avoid either wrongfully labeling a driver as impaired or assuming someone is capable of driving when they are not, there is a considerable need for further research on these issues.

THE RIGHT CANNABIS POLICIES CAN MITIGATE POTENTIAL HARMS

While opponents of legalization rely heavily on concerns that cannabis—especially in its modern form—is inherently dangerous to public health and safety, advocates often tout the substance as risk free. Our review of the literature around the five top fears we identified indicates that the reality lies somewhere in between. The consumption of high-potency cannabis is not without its risks, especially with regard to driving impairment and accidental intake by young people, but criminalization often comes with severe consequences of its own. Therefore, as more states look into legalization and as the federal government considers decriminalization and de-scheduling, we recommend a “harm reduction” approach to the following regulatory priorities.

Potency, Labeling and Dosing Standards

As previously discussed, THC levels may indeed be increasing in both legal and illegal cannabis markets. Although these higher-potency products may have potential short- and long-term health and safety risks for consumers, legal markets offer the opportunity for precise regulation and labeling of products, giving individuals the agency to adjust their use accordingly.⁶²

Thus far, the responsibility to regulate cannabis potency and safety from contaminants has fallen on the states that have legalized the substance for medical or recreational use. This has resulted in inconsistent standards and sometimes inaccurate labeling.⁶³ For example, although many states prohibit packaging that may appeal to youth, only some require clear

THC labeling or single-dose packaging of edibles.⁶⁴ Shifting the fundamental task of setting potency standards to the Food and Drug Administration would improve product consistency and support state testing and regulation efforts without undermining individual states’ approaches to legalization.

Furthermore, although all U.S. states require cannabis products to be labeled for THC content, evidence suggests that consumers may struggle to make sense of labeling information.⁶⁵ Clear labeling and dose-based packaging have been shown to help improve consumers’ product knowledge, potentially reducing the risk of overconsumption or accidental poisoning.⁶⁶ This is another area in which federal guidance can provide clear standards to help ensure product safety and efficacy and to help individuals make informed decisions, regardless of the state in which they live. For example, the Centers for Disease Control and Prevention currently provides guidelines regarding adult alcohol consumption, including what constitutes a single drink of alcoholic beverages of varying potencies; a similar concept could be applied to cannabis consumption.⁶⁷

Driving Under the Influence

There is increasing evidence that THC consumption contributes to at least some driving impairment, and no state permits intoxicated driving. As of September 2021, five states had specific *per se* limits for THC, 12 states had “zero tolerance” laws and Colorado had a THC limit for drivers but allowed them to contest the assumption of intoxication with affirmative evidence.⁶⁸

Unfortunately, the use of *per se* limits is problematic because of vast individual variation, delays in blood testing suspected drivers, and the lack of consistent association between THC

61. Megan Grabenauer, “Differences in Cannabis Impairment and Its Measurement Due to Route of Administration: Final Summary Overview,” RTI International, December 2020, pp. 1-11. <https://www.ojp.gov/pdffiles1/nij/grants/255884.pdf>.

62. Justin Matheson and Bernard Le Foll, “Cannabis Legalization and Acute Harm From High Potency Cannabis Products: A Narrative Review and Recommendations for Public Health,” *Frontiers in Psychiatry* (Sept. 23, 2020). <https://www.frontiersin.org/articles/10.3389/fpsy.2020.591979/full>.

63. Daniel J. Kruger et al., “Requirements for Cannabis Product Labeling by U.S. State,” *Cannabis and Cannabinoid Research* (Jan. 11, 2021). <https://www.liebertpub.com/doi/abs/10.1089/can.2020.0079>; Ryan Vandrey et al., “Cannabinoid Dose and Label Accuracy in Edible Medical Cannabis Products,” *JAMA* 313:24 (June 2015), pp. 2491-2493. <https://jamanetwork.com/journals/jama/fullarticle/2338239>.

64. Camille Gourdet et al., “How four U.S. states are regulating recreational marijuana edibles,” *International Journal of Drug Policy* 43 (May 2017), pp. 83-90. <https://www.sciencedirect.com/science/article/abs/pii/S0955395917300361>.

65. Kruger et al. <https://www.liebertpub.com/doi/abs/10.1089/can.2020.0079>; David Hammond, “Communicating THC levels and ‘dose’ to consumers: Implications for product labelling and packaging of cannabis products in regulated markets,” *International Journal of Drug Policy* 91 (May 2021). <https://www.sciencedirect.com/science/article/abs/pii/S0955395919301823>.

66. Samantha Goodman and David Hammond, “Does Unit-Dose Packaging Influence Understanding of Serving Size Information for Cannabis Edibles?” *Journal of Studies on Alcohol and Drugs* 81:2 (April 2020), pp. 173-179. <https://www.jsad.com/doi/abs/10.15288/jsad.2020.81.173>.

67. “Dietary Guidelines for Alcohol,” Centers for Disease Control and Prevention, Dec. 29, 2020. <https://www.cdc.gov/alcohol/fact-sheets/moderate-drinking.htm#:~:text=To%20reduce%20the%20risk%20of,when%20alcohol%20is%20consumed>.

68. “Drugged Driving: Marijuana-Impaired Driving,” National Conference of State Legislatures, Sept. 23, 2021. <https://www.ncsl.org/research/transportation/drugged-driving-overview.aspx>.

blood levels and the corresponding degree of impairment.⁶⁹ Indeed, based on the examples discussed in the previous section, current cutoffs will exclude many people who are driving impaired while wrongly labeling other individuals who are sober or unimpaired. Several jurisdictions are running pilot programs to assess new ways to test THC levels or recent cannabis consumption promptly.⁷⁰ These types of programs, if successful, could provide alternatives to *per se* limits. As such, the strongest policies will be flexible enough to adapt to emerging evidence and adopt improved procedures as they become available.

Continuing to Prevent Youth Use

The fact that youth cannabis consumption appears to have been largely unaffected by state-level legalization is promising on a policy level and supports the belief that current efforts are working and should be continued.

It is noteworthy that, to date, all of the states that have legalized recreational cannabis require an individual to be 21 years or older to purchase or possess it. This age restriction could be bolstered by federal legislation in the same way that tobacco age restrictions recently have been.⁷¹

A study of age-checking at dispensaries in Colorado and Washington states revealed high compliance with age-restriction laws. Indeed, shops in the study refused more than 92 percent of underage purchase attempts.⁷² However, this study also highlights areas for improvement. For example, compliance was higher in Colorado, where IDs are checked at the door and at the point of purchase, suggesting that this two-step approach may represent a relatively easy way to further improve compliance.⁷³ In addition, states should prioritize regular compliance checks and ensure that the necessary human and economic resources are in place to do so.

One point of concern that some experts continue to cite around youth use is the steady decline in the perceived harm associated with cannabis consumption, as perceptions of

harm tend to play a protective role against starting to use a substance. Research suggests that teens' perceptions of cannabis-related risk have been declining since at least 1990.⁷⁴ Although this change in attitude appears to predate legalization and perhaps reflects a broader cultural shift, it supports the value of youth prevention campaigns. For example, a study of Denver, Colorado's "High Costs" campaign—an interactive multimedia effort that eschews fear-based tactics for facts—showed that the majority of surveyed youth who saw the campaign found the content to be engaging and educational. In fact, 81 percent of those who had seen the ads reported that they influenced their decision to not use cannabis.⁷⁵ States should therefore continue to develop and support evidence-based youth prevention campaigns, ideally using tax dollars raised from legal markets.

CONCLUSION

Despite growing support across the United States for loosening laws around cannabis, opposition still exists. The messaging that opponents of legalization use in campaigns tends to focus on similar themes and strong appeals to emotion.

Although some of the concerns expressed by anti-legalization campaigns draw on scientific literature, the majority paint an incomplete picture. In reality, although cannabis is not a risk-free cure-all, it also does not pose a great risk to the health and welfare of the American public. As legislators at the state and federal levels grapple with how best to regulate cannabis, it is vital that they consider the most current scientific research findings to inform their efforts. Evaluation of the scientific evidence suggests that smart, targeted and strategic policy can support safe legal markets for medical and recreational cannabis. Specifically, approaches that target potency transparency and consistency; improved research and education around intoxicated driving; and continued youth prevention and education campaigns can all reduce potential public health and safety consequences.

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69. "Marijuana-Impaired Driving: A Report to Congress," National Highway Traffic Safety Administration, U.S. Department of Transportation, July 2017, pp. 28-29. <https://www.nhtsa.gov/sites/nhtsa.gov/files/documents/812440-marijuana-impaired-driving-report-to-congress.pdf>.

70. "Drugged Driving: Marijuana-Impaired Driving." <https://www.ncsl.org/research/transportation/drugged-driving-overview.aspx>.

71. "Tobacco 21," U.S. Food and Drug Administration, Sept. 1, 2021. [https://www.fda.gov/tobacco-products/retail-sales-tobacco-products/tobacco-21#:~:text=This%20legislation%20\(known%20as%20%E2%80%9CTobacco,and%20persons%20with%20no%20exceptions](https://www.fda.gov/tobacco-products/retail-sales-tobacco-products/tobacco-21#:~:text=This%20legislation%20(known%20as%20%E2%80%9CTobacco,and%20persons%20with%20no%20exceptions).

72. David B. Buller et al., "Compliance With Personal ID Regulations by Recreational Marijuana Stores in Two U.S. States," *Journal of Studies on Alcohol and Drugs* 80:6 (November 2019), pp. 679-686. <https://www.jsad.com/doi/pdf/10.15288/jsad.2019.80.679>.

73. Ibid.

74. Richard Miech et al., "Prevalence and Attitudes Regarding Marijuana Use Among Adolescents Over the Past Decade," *Pediatrics* 140:6 (December 2017). <https://publications.aap.org/pediatrics/article/140/6/e20170982/38212/Prevalence-and-Attitudes-Regarding-Marijuana-Use>.

75. "2019 High Costs Campaign Evaluation, Denver Teens Survey: November-December 2019," Insights Lab, February 2020. https://www.thehighcosts.com/wp-content/uploads/2020/02/HighCosts_2019Post-CampaignSurvey_Results.pdf.