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LEGAL WEED: A LIFESAVER?

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THESIS

LEGAL WEED: A LIFESAVER?

by

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Marijuana legalization in Colorado has brought with it many changes, affecting economic, social, and criminal elements. According to law enforcement statistics, cannabis legalization has shown a consistent rise in opioid overdose rates throughout the United States; however, recent scholarly research indicates that states that have legalized marijuana experience a noticeable decrease in opioid overdose rate. This thesis uses case study analysis to answer the question: Does marijuana legalization save lives in Colorado? Through a market-based examination of Mexican drug trafficking organizations, conclusions are drawn on the impact of marijuana legalization vis-à-vis the illicit opioid trade. The author reviews the physical and mental effects of cannabis use on the body and conducts a comparison of Uruguay and Colorado legalization. Best practices from the repeal of Prohibition and Uruguay's successes with legalization are extrapolated to recommend changes to Denver's approach to marijuana. Colorado's experience with legalization, when taken in total with suicides, traffic safety reports, opioid overdoses, and other indicators, is a mixed bag: there is no clear evidence that marijuana legalization saves lives at this point in the state's history. More data and more accurate testing are needed before conclusions can be drawn.

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LEGAL WEED: A LIFESAVER?

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ABSTRACT

Marijuana legalization in Colorado has brought with it many changes, affecting economic, social, and criminal elements. According to law enforcement statistics, cannabis legalization has shown a consistent rise in opioid overdose rates throughout the United States; however, recent scholarly research indicates that states that have legalized marijuana experience a noticeable decrease in opioid overdose rate. This thesis uses case study analysis to answer the question: Does marijuana legalization save lives in Colorado? Through a market-based examination of Mexican drug trafficking organizations, conclusions are drawn on the impact of marijuana legalization vis-à-vis the illicit opioid trade. The author reviews the physical and mental effects of cannabis use on the body and conducts a comparison of Uruguay and Colorado legalization. Best practices from the repeal of Prohibition and Uruguay's successes with legalization are extrapolated to recommend changes to Denver's approach to marijuana. Colorado's experience with legalization, when taken in total with suicides, traffic safety reports, opioid overdoses, and other indicators, is a mixed bag: there is no clear evidence that marijuana legalization saves lives at this point in the state's history. More data and more accurate testing are needed before conclusions can be drawn.

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LIST OF ACRONYMS AND ABBREVIATIONS

Δ-9 THC	delta-9 tetrahydrocannabinol
CDC	Centers for Disease Control and Prevention
CDPHE	Colorado Division of Public Health and Environment
DEA	Drug Enforcement Administration
DoD	Department of Defense
DUI	driving under the influence
ED	emergency department
FARC	Fuerzas Armadas Revolucionarias de Colombia
IRCCA	Institute for the Regulation and Control of Cannabis (Uruguay)
MME	morphine milligram equivalents
NHTSA	National Highway Traffic Safety Administration
PDMP	prescription drug monitoring program
THC	tetrahydrocannabinol
SAM	Smart Approaches to Marijuana
SFST	Standard Field Sobriety Test
TOC	transnational organized crime
UNODC	United Nations Office on Drugs and Crime

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EXECUTIVE SUMMARY

At the OxyContin launch party in the mid-1990s, Richard Sackler, a member of the family that owns Purdue Pharma, stepped up to the podium to address the audience. Sackler, then senior vice president for sales, proclaimed that the launch party would be "followed by a blizzard of prescriptions that will bury the competition. The prescription blizzard will be so deep, dense, and white."[1]

A quarter of a century later, deaths caused by the opioid epidemic have reached an all-time high in the United States—with opioids responsible for over 72,000 deaths in 2017 alone.[2] The Sackler family and Purdue Pharma face multiple lawsuits from the state of Massachusetts and county governments. In the lawsuit brought forward by Massachusetts, the attorney general claims that "the Sacklers made Richard's boast come true…. They created a manmade disaster. Their blizzard of dangerous prescriptions buried children and parents and grandparents across Massachusetts, and the burials continue."[3] Although both the Sackler family and Purdue Pharma deny these allegations, the company halted its OxyContin marketing campaign to doctors.

A quarter century has brought other changes as well to the world of legal drugs in the United States. Colorado, one of the first of many states to legalize the recreational sale and use of marijuana, is also experiencing an opioid overdose epidemic. Scientific research indicates, however, that states that have legalized marijuana have decreased rates of opioid overdoses.

This thesis answers the question: Does marijuana legalization in Colorado save lives? Beginning with a close examination of the studies claiming that states that have legalized marijuana suffer fewer opioid overdoses than those that still prohibit the drug, this thesis conducts a thorough analysis of the medical effects of marijuana on both youth

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[1] Alanna Durkin Richer and Geoff Mulvihill, "Prosecutor: Drug Maker Pushed OxyContin Despite Danger Signs," Associated Press, January 16, 2019, https://apnews.com/be983b7bd994487289ec8b167a977bc8.

[2] Richer and Mulvihill.

[3] Richer and Mulvihill.

and adults. Medical research indicates few to no lasting effects to adults, but youth-onset users have a noticeable cognitive decline in their adult years.[4] Public health does not simply compare overdoses to recreational drug use; other factors come into play as well, to include traffic safety. In that regard, research is mixed on the impact of marijuana use and driver impairment, undecided on what actually to test for in suspected marijuana-impaired traffic incidents, and operationally inconsistent in how both law enforcement officers and coroners test for marijuana use. The result? Any conclusions that can be drawn from data surrounding marijuana use and traffic fatalities in Colorado since legalization six years ago should be met with skepticism.

Drug trafficking organizations have not been static since marijuana legalization in Colorado and other states. Using a business model, this thesis examines key markers to determine if Mexican cartels have adapted to legalized marijuana. Based upon such indicators as the price of heroin, the market dominance of Mexican groups, recent cultivation increases, and the number of heroin-related arrests, it appears that Mexican groups have adapted to the new world of legal marijuana—and are pushing a cheap, highly addictive product more and more to Americans as they are transitioning off other opioid products.

The repeal of Prohibition in the United States is also examined within the context of current marijuana legalization, and many positive benefits of this type of repeal are again manifesting, almost 100 years later, as the same action is taken toward marijuana. Fewer youths use, there is more quality control over the product, and less crime is reported in Colorado. In addition, with law enforcement agencies freed up from dealing with marijuana-related crimes, other cases are being worked—and solved—at higher rates.

From a public health perspective, mental health in Colorado in the age of legal marijuana remains relatively unchanged, with minor caveats. Although Coloradans are committing suicide at record amounts year after year, research indicates that marijuana use

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[4] Madeline H. Meier et al., "Cannabis Use and Neuropsychological Decline," *Proceedings of the National Academy of Sciences* 109, no. 40 (October 2012): E2657–E2664, http://doi.org/10.1073/pnas.1206820109.

is not tied to increased rates of suicide.[5] Once victims' confounding variables are accounted for, such as psychological problems, there is no direct link between suicide and marijuana use.[6]

American pharmaceutical companies and their marketing campaigns are also examined in this thesis, along with the marijuana industry's lobbying efforts. The results indicate a more malleable public that accepts legalized marijuana and increasingly buys into the idea of marijuana use promoting a healthy lifestyle. In terms of licit opioids, however, almost all positive impacts (from an industry perspective) have been played out. In recent years, the amount of opioids prescribed has consistently decreased and, as the Purdue Pharma example indicates, government and public dissatisfaction with the role that Big Pharma has had in the opioid epidemic is growing.[7]

Although Uruguay legalized marijuana for a variety of reasons other than popular support, its experiences can be used to help strengthen Colorado's policies. Specifically, the use of a database adopted solely for the purpose of limiting purchases to the legal limit may help minimize youth and intra-state commerce access. In addition, legal limits on tetrahydrocannabinol (THC), the psychoactive compound in cannabis, may decrease medical issues associated with high-dose use of retail products.

Marijuana legalization has largely had no impact on public health in Colorado. Each year, more and more people are committing suicide, dying on the roads, and overdosing on opioids. Marijuana has done little to stem these tragedies, with the exception of overdoses being mitigated somewhat by legal cannabis. More research needs to be conducted in Colorado and other states that have legalized marijuana, with accurate and consistent data on drug impairment and polydrug (alcohol/marijuana) incidents. This thesis concludes by recommending a variety of policy changes in Colorado, explaining how many state agencies can be used to effect positive change.

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[5] Ceri Price et al., "Cannabis and Suicide: Longitudinal Study," *British Journal of Psychiatry*, 195, no. 6 (January 2018): 492, https://doi.org/10.1192/bjp.bp.109.065227.

[6] Price et al, 492.

[7] "CDC: Opioid Prescription Rate Remains High," *The Clinical Advisor* 20, no. 8 (August 2017): 12, http://libproxy.nps.edu/login?url=https://search.proquest.com/docview/1947428885?accountid=12702.

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I. CANNABIS AND PUBLIC HEALTH: AN INTRODUCTION

A. RESEARCH QUESTION

This thesis answers the following question: Does marijuana legalization save lives in Colorado?

B. PROBLEM STATEMENT

Marijuana legalization is becoming widespread throughout the United States. Twenty-one years ago, a medical marijuana law was adopted by California. Since then, twenty-nine states have approved similar laws. In 2012, Colorado and the District of Columbia were the first to legalize retail marijuana. As of 2019, ten states, along with the District of Columbia, have legal retail marijuana distributors.[1]

At the same time that marijuana legalization has increased at the state level, opioid—both licit and illicit—overdose rates have increased throughout the country. In February 2017, U.S. Representative Donald Norcross (D-NJ) addressed participants at a bipartisan meeting on heroin in Washington, DC. He stated that 50,000 Americans died in 2015 because of drug overdoses, more than those who died from terrorism, firearms, automobile accidents, or war.[2] He added, "This is more than just a public health emergency—it's a threat to our national security."[3]

As users increasingly substitute marijuana for opioids (licit or illicit), research indicates that Colorado's recent marijuana legalization may have a mitigating effect on opioid overdose rates. Statistical research finds a correlation between marijuana legalization and a decrease in opioid overdose rates. A November 2017 *American Journal of Public Health* study conducted by Melvin D. Livingston et al. focused on the years 2000

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[1] Jeremy Berke, "This Map Shows Every U.S. State Where Pot Is Legal," *Times Union*, January 4, 2019, https://www.timesunion.com/technology/businessinsider/article/This-map-shows-every-state-that-has-legalized-12519184.php.

[2] "Rep. Norcross Fights for NJ Families at Heroin Task Force Hearing," news release, Norcross Media Center, February 7, 2017, https://norcross.house.gov/media-center/press-releases/heroin-task-froce.

[3] Norcross Media Center.

through 2015, including the two years of marijuana legalization in Colorado (2014 and 2015). The results indicate an "estimated 6.5% reduction in opioid-related deaths."[4]

Public health outcomes, however, are not simply defined by the number of opioid overdoses per year. Many other factors play into overall public safety and health, to include traffic fatalities, drug trafficking, and the mental health of Colorado citizens.

- **Traffic safety:** Federal and private think tank organizations cannot agree on whether or not legalized marijuana is a direct cause of increased traffic fatality rates in the United States. From a traffic safety perspective, marijuana use and its impact on highway safety necessitates further research; inconsistent crash and coroner toxicology reporting is widespread throughout the state.[5]

- **Opioid addiction and overdose rates:** Big Pharma continues its national push to encourage doctors and health-care conglomerates to prescribe opiates.[6] Reporting indicates that many Americans who are prescribed opioids transition to heroin when their prescriptions expire; for most heroin addicts (80 percent), their addiction began with opioid pain relievers (OPRs).[7] As stated in the *Annual Review of Public Health*, "many of these individuals appear to be switching to heroin after

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[4] Melvin D Livingston et al., "Recreational Cannabis Legalization and Opioid-Related Deaths in Colorado, 2000–2015," *American Journal of Public Health* 107, no. 11 (2017): 1827, https://doi.org/10.2105/AJPH.2017.304059.

[5] David Migoya, "Traffic Fatalities Linked to Marijuana Are up Sharply in Colorado. Is Legalization to Blame?," *Denver Post*, August 25, 2017, https://www.denverpost.com/2017/08/25/colorado-marijuana-traffic-fatalities/.

[6] Andrew Kolodny et al., "The Prescription Opioid and Heroin Crisis: A Public Health Approach to an Epidemic of Addiction," *Annual Review of Public Health* 36, no. 1 (March 2015): 562, https://doi.org/10.1146/annurev-publhealth-031914-122957.

[7] Pradip K. Muhuri, Joseph C. Gfroerer, and M. Christine Davies, *Associations of Nonmedical Pain Reliever Use and Initiation of Heroin Use in the United States* (Rockville, MD: Center for Behavioral Health Statistics and Quality, August 2013), http://www.samhsa.gov/data/sites/default/files/DR006/DR006/nonmedical-pain-reliever-use-2013.htm.

becoming addicted to OPRs because heroin is less expensive on the black market."[8]

- **Illicit opioid trafficking:** Mexican cartels gained heroin market control within the past ten years, and Chinese pharmaceutical companies peddle fentanyl, an even more deadly opiate.[9] In their most recent overdose statistics, from 2015, the National Institute on Drug Abuse and the Centers for Disease Control report that 72 percent of illicit opioid overdoses were due to fentanyl.[10] The growing trend in fentanyl overdoses bears monitoring and possibly further research, especially considering that the drug's countries of origin include Mexico and China, two prominent trade partners with the United States.[11]

- **Mental health**: In addition to their physical health, the mental health of Colorado citizens should be examined to gain an overall view of public health in the Centennial State. This includes an analysis of suicide rates before and after legalization, as well as the impact of "healthy lifestyle choices" made by the marijuana industry.

A close examination of these factors, along with opioid overdose rates, can help draw a clearer picture of the overall public health and safety of Colorado and its citizens.

This intersection—of legal marijuana and opioid addiction—can be viewed through the lens of the varying interests of the stakeholders, which include elected officials, government officials, citizens, lobbying firms, and scientific research groups. These

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[8] Kolodny et al., "The Prescription Opioid and Heroin Crisis."

[9] Drug Enforcement Administration (DEA), *The Heroin Signature Program and Heroin Domestic Monitor Program 2014 Reports* (Springfield, VA: Drug Enforcement Administration, September 2016), https://ndews.umd.edu/sites/ndews.umd.edu/files/pubs/hspdmp2014reports.pdf; DEA, *National Drug Threat Assessment Summary* (Washington, DC: Drug Enforcement Administration, November 2016), https://www.dea.gov/resource-center/2016%20NDTA%20Summary.pdf.

[10] "Overdose Death Rates," National Institute on Drug Abuse, last modified September 2017, https://www.drugabuse.gov/related-topics/trends-statistics/overdose-death-rates.

[11] DEA, *National Drug Threat Assessment Summary*, vii.

stakeholders' interests shape how medical and scientific data are portrayed in mass media as well as in political processes. Colorado, one of the first two states to legalize retail marijuana six years ago, is a perfect entity to use to examine the overall public health impact of legal marijuana. This research will conclude by prescribing policy tradeoffs that can be made when considering the overall impact of legal marijuana on U.S. citizens' health.

C. LITERATURE REVIEW

The purpose of this literature review is to explore the commonalities and disparities among recent studies analyzing cannabis use and opioid overdose rates in the United States. The review also examines the impact of legalized marijuana on public health, from physical and emotional impacts on the body to public safety. The review is organized into several sub-categories, including the statistical analysis of marijuana legalization and opioid overdoses as well as the medical impact of marijuana. Note that for the purposes of this study, the terms *cannabis* and *marijuana* are used interchangeably, even though marijuana refers to the dried cannabis plant.

1. Opioid Overdose Rates in States with Legal Marijuana

Recent studies indicate that states with medical marijuana laws or legal retail marijuana show a corresponding drop in opioid overdose rates.[12] Although overall opioid overdose rates (both intentional or suicidal, and accidental) have increased in all fifty states, the overdose rates appear to be stabilizing in states that have adopted medical cannabis laws.[13] While considering deaths solely from *intentional* opioid overdoses, the results indicate a "*borderline* significant association between laws and opioid analgesic overdose mortality" (emphasis mine).[14]

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[12] Marcus Bachhuber et al., "Medical Cannabis Laws and Opioid Analgesic Overdose Mortality in the United States, 1999–2010," *JAMA Internal Medicine* 174, no. 10 (October 2014): 1668–73, https://doi.org/10.1001/jamainternmed.2014.4005.

[13] Bachhuber et al., 1670.

[14] Bachhuber et al., 1670–71.

Livingston et al. consider Colorado's prescription drug monitoring program (PDMP) and how it has changed. Specifically, all pharmacists and opioid prescribers had to "register with, but not necessarily use, the prescription drug monitoring program by the end of 2014."[15] Their study concludes that changes in Colorado's prescription drug monitoring program, rather than the legalization of marijuana, might explain the decrease in opioid-related deaths.[16] The authors of this study readily acknowledge "oxycodone-caused mortality abruptly declined 25 percent the month after implementation of Florida's PDMP," a program intended to track the number of prescription drugs one person is getting despite having multiple doctors prescribing those drugs.[17]

Examining the links between marijuana use and opioid abuse/overdose rates at national and state levels will help determine causation, but examining the linkages at the personal level can be even more revealing. One such study examines three Canadian citizens—a woman afflicted with multiple sclerosis, a man afflicted with acute neuropathy due to HIV, and a man suffering from a work-related back injury.[18] All three had been using prescribed opioids (including morphine) to counter their conditions; in each case, after being prescribed marijuana under the Medical Marijuana Access Program, they reported a decrease in pain thresholds and a decrease in opioid use.[19] Mary Lynch and Alexander Clark attribute this change to "cannabinoids block[ing] pain responses in virtually every laboratory pain model tested."[20] The common theme within each of the aforementioned studies is a correlation between a decrease in opioid mortality rates at the

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15 Livingston et al., "Cannabis Legalization and Opioid-Related Deaths," 1828.

16 Livingston et al., 1829.

17 See Chris Delcher et al., "Abrupt Decline in Oxycodone-Caused Mortality after Implementation of Florida's Prescription Drug Monitoring Program," *Drug and Alcohol Dependence* 150 (May 2015): 63–68, https://doi.org/10.1016/j.drugalcdep.2015.02.010.

18 Mary Lynch and Alexander Clark, "Cannabis Reduces Opioid Dose in the Treatment of Chronic Non-cancer Pain," *Journal of Pain and Symptom Management* 25, no. 6 (June 2003), https://doi.org/10.1016/S0885-3924(03)00142-8.

19 Lynch and Clark, 496–98.

20 Lynch and Clark, 496.

state level and the legalization of marijuana, with one study concluding that the legalization of marijuana decreases opioid overdose rates by 24.8 percent.[21]

In terms of opioid overdose rates, several factors need to be considered—besides the legalization of marijuana—before conclusions can be drawn. One such issue is the widespread availability and use of Narcan (or the generic, naloxone, used to treat opioid overdoses). It has recently been classified as a non-prescribed medication, prompting one Denver paramedic to state, "I think it would be a very safe assumption that because the medication is available over the counter, our numbers [of EMTs using Narcan] have decreased."[22] Is the proliferation of Narcan/naloxone, both to first responders and private citizens, having an impact on overall opioid overdose rates? What about increases in admissions to drug treatment centers? Colorado's Department of Behavioral Health reports that rehabilitative admissions to hospitals for heroin addiction increased from 55 in every 100,000 people to 120 in 100,000 between 2012 and 2016.[23] Could this increase in the use of rehabilitative centers be another factor in shaping opioid overdose rates? An extensive literature review has revealed that no one has looked into this potential factor.

In addition, disagreements exist over the effects of PDMPs. Marcus Bachhuber et al. suggest a weak link between the existence of PDMPs and a decrease in opioid overdose mortality, while Livingston et al. "controlled for comparison state trends and Colorado's PDMP" yet found opioid-related deaths decreased by 6.5 percent.[24] David Powell, Rosalie Pacula, and Mireille Jacobsen posit that the research surrounding any positive impacts (i.e., a decrease in opioid overdose rates) due to an active PDMP are

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[21] Bachhuber et al., "Medical Cannabis Laws and Opioid Analgesic Overdose Mortality," 1670.

[22] Michael Roberts, "Nearly Three Heroin/Opioid Overdoses per Day in Denver during 2017," Westword, November 8, 2017, http://www.westword.com/news/denver-heroin-and-opioid-overdoses-and-narcan-use-9920469.

[23] Rebecca Helfand, "Colorado Drug Trends" (presentation, Colorado Office of Behavioral Health, August 2017), 11, https://coag.gov/sites/default/files/contentuploads/oce/Substance_Abuse_SA/SATF_presentations/2017_colorado_drug_trends_report.pdf.

[24] Bachhuber et al., "Medical Cannabis Laws and Opioid Analgesic Overdose Mortality," 1673; Livingston et al., "Cannabis Legalization and Opioid-Related Deaths," 1829.

"inconclusive," despite having "received the most serious attention."[25] State-level PDMPs may have a limited positive effect in decreasing opioid overdose mortality rates, but more research needs to be conducted over an extended period of time. One complicating factor is that some states, such as Colorado, are adopting PDMPs at the same time as they are legalizing marijuana; any cause-effect analysis may therefore be problematic.

2. Long-Term Impact of Marijuana

One of the primary outcomes of any burgeoning public health issue put to the pollsters is misinformation. In the case of marijuana legalization, this information is typified by both a lack of conclusive research as well as over-the-top claims on both sides of the legalization argument.[26]

a. Positive and Not-So-Positive Impacts

Ample research touts the positive impacts of marijuana. In this section, I examine the main areas in which researchers highlight the public health benefits of cannabis use as well as some contradictory research.

Drawing upon a study conducted by Stanford University researchers which examined over 50,000 cannabis users ages twenty-five to forty-five, Halliday teases major arguments out of the data in favor of marijuana use. From a physical or psychological addiction perspective, "10 percent of people who use will develop something that looks like dependence at some point in their lives … that's much lower than heroin, cocaine, and tobacco."[27] From a driving perspective, Halliday asserts that cannabis intoxication has a negative impact on both cognitive perception and motor skills, but adds that a current blood test measuring THC levels "isn't a reliable indicator of how high you are."[28]

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[25] David Powell, Rosalie Pacula, and Mireille Jacobson, "Do Medical Marijuana Laws Reduce Addictions and Deaths Related to Pain Killers?," *Journal of Health Economics* 58 (March 2018): 30, https://doi.org/10.1016/j.jhealeco.2017.12.007.

[26] Matthew Halliday, "But What Does Science Say?" *Chatelaine* 91, no. 5 (September 2018): 79, http://libproxy.nps.edu/login?url=https://search.proquest.com/docview/2085005600?accountid=12702.

[27] Halliday, 79.

[28] Halliday, 79.

Using the same data set to examine impacts on sex life, researchers found that routine cannabis users had sex more frequently than nonusers and reported no impaired sexual functioning. In terms of cancer, Halliday states that "research found no link between head and neck cancers and cannabis use. Similar studies on other cancers have shown no link or, at most, a very weak or uncertain links."[29]

Within the state of Colorado, the state agency tasked with managing the transition to legal retail marijuana is the Colorado Division of Public Health and Environment, or CDPHE. The agency examined the current medical literature of any *substantial* or *moderate* evidence of health impacts. CDPHE defines substantial evidence as associations backed up by robust scientific findings; moderate evidence implies an association between marijuana use and the outcome, but the findings have some limitations.[30] Table 1 highlights the agency's findings. Careful examination of CDPHE's exhaustive scientific literature review indicates that some disagreement exists on whether or not smoking marijuana causes cancer. With the exception of short-term, intoxication-induced symptoms such as bronchitis, cyclic vomiting, and psychotic episodes, there are very few long-term physical impacts. From a psychological perspective, memory and motor skills are impacted. This is where divergence in medical research ends.[31]

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[29] Halliday, 79.

[30] Colorado Division of Public Health and Environment (CDPHE), *Scientific Literature Review on Potential Health Effects of Marijuana Use, 2016* (Denver, CO: State Printing Office, 2016), https://drive.google.com/file/d/0B0tmPQ67k3NVSUYtQlZkTHRVXzg/view.

[31] CDPHE.

Table 1. Medical Impact of Marijuana on Adults[32]

Association in Adults	**Substantial**	**Moderate**
Respiratory	Chronic bronchitis with cough/wheeze/sputum; acute use improves airflow	
Cancer: chemicals in marijuana smoke or vapor	Tobacco and marijuana smoke have the same cancer-causing compounds	
Cancer: cancer and precancerous lesions	Precancerous lesions with daily or near daily use	No lung cancer association with less than 10 years of smoking marijuana
Cardiovascular effects		Increased risk of ischemic stroke in individuals younger than 55
Driving	Recent use increases vehicle crashes	Crash risk increases with THC detected
Gastrointestinal		Frequent vomiting with long-time and daily use
Cognitive effects	Impaired memory for at least 7 days	
Mental health effects	Acute psychotic symptoms during intoxication	Psychotic disorder in adulthood
Substance use and addiction	Can develop marijuana addiction; withdrawal symptoms in long-term users, treatment of addiction can reduce use and dependence	

[32] Adapted from CDPHE.

b. Negative Impacts

CDPHE's review of medical literature shows a striking contrast between the relative lack of negative impacts on adults and those in adolescents (see Table 2). Using CDPHE terminology, "robust" evidence shows consistent marijuana use beginning in the adolescent years can have long-term physical and psychological impacts that last into adulthood. These include impaired cognitive abilities, psychotic disorders, and possible illicit drug use and alcohol or tobacco addiction in later years.

Table 2. Medical Impact of Marijuana on Youth[33]

Association	Substantial	Moderate
Cognitive and Academic	Decreased high school graduation rates	Impaired cognitive abilities and academic performance after 28 days abstinence
Mental Health	Psychotic symptoms in adulthood	Psychotic disorder in adulthood (daily or near-daily users)
Substance use, abuse, and addiction	Can develop marijuana addiction	Increased marijuana use and addiction after adolescence
	Other illicit drug use and addiction after adolescence	Alcohol or tobacco use and addiction after adolescence
Benefits of quitting	Treatment for marijuana addiction can reduce use and dependence	Quitting marijuana lowers risk of cognitive and mental health effects

Recent studies that outline the benefits of marijuana even for adults, however, typically overlook the long-term negative impacts of marijuana as a substitute for opioids. The side effects of marijuana have been well documented; Sol Goldenberg reports that

[33] Adapted from CDPHE.

tachycardia, respiratory problems, and risks to pregnant women are evident in users.[34] Long-term users "may develop mental effects such as temporary hallucinations, temporary paranoia, depression, suicide, and worsening symptoms in schizophrenic patients."[35] In addition, animal studies have shown that the active ingredient in marijuana "makes other drugs more pleasing to the brain."[36]

Additional research suggests that "frequent marijuana use seems to strengthen the relationship between pain and depression and anxiety, not ease it."[37] Marian Wilson of the Washington State University College of Nursing conducted a study on the use of cannabis and its effects on the interplay between pain, depression, and anxiety. Wilson's study indicates that although patients may *believe* marijuana helps them cope, the exact opposite may be true: patients find it hard to manage their symptoms due to a strengthening of the pain-emotional distress connections.[38]

3. Traffic Safety and Marijuana Use

At the national level, people strongly disagree about whether or not legalized marijuana, both retail and medical, increases traffic fatalities. The *Denver Post* reported on a wide spectrum of scientific findings in a 2017 report, which began by detailing suspected links between cannabis use and fatal crashes. Citing a *Clinical Chemistry* journal article and a University of Colorado research program, the report mentions a roughly 66-percent increase in drivers involved in fatal crashes testing positive for marijuana use between 2009

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[34] Sol Goldenberg, "Decriminalization of Marijuana: Gateway to Substance Abuse?," *AMT Events* 34, no. 1 (March 2017): 18, https://www.americanmedtech.org/Portals/0/PDF/Be%20Involved/publications-sample/AMT_EventsMar2017_Preview.pdf.

[35] Goldenberg.

[36] Goldenberg.

[37] Marian Wilson et al., "Cannabis Use Moderates the Relationship between Pain and Negative Affect in Adults with Opioid Use Disorder," *Addictive Behaviors* 77 (2018): 235, https://www.readbyqxmd.com/read/29078148/cannabis-use-moderates-the-relationship-between-pain-and-negative-affect-in-adults-with-opioid-use-disorder

[38] Wilson et al., 235.

and 2011.[39] The same *Denver Post* article mentioned that, in 2015, the National Highway Traffic Safety Administration (NHTSA) released a twenty-month Virginia Beach study that concluded, after adjusting for alcohol concentration, age, ethnicity, and gender, the presence of drugs does not equate to a heightened crash rate.[40] It went on to state that "other variables (age, gender, ethnicity and alcohol use) were highly correlated with drug use and account for much of the increased risk associated with the use of illegal drugs and with THC."[41] In a study by the Washington Traffic Safety Commission, conducted almost concurrently with the NHTSA study, stoned drivers were shown to face double the risk of being involved in a fatal crash.[42]

Different reporting standards and limitations in measuring impairment make judgments on driver ability extremely difficult to make. Widely inconsistent crash and coroner toxicology reporting appears throughout the state of Colorado.[43] This inconsistency makes it difficult, if not impossible, to determine the impact of legalized marijuana on the citizens of Colorado. In addition, the combination of a field sobriety test and a sometimes-administered blood test may not be measuring actual impairment.[44] Colorado's mandated a maximum level of Delta-9 tetrahydrocannabinol (Δ-9 THC) in the bloodstream of 5 ng/mL may be an arbitrary level not supported by science.[45] Finally, numerous psychoactive compounds can be found within marijuana, and Δ-9 THC blood

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[39] David Migoya, "Are You High? The Science of Testing for Marijuana Impairment Is Hazy, and Evolving," *Denver Post*, December 16, 2017, https://www.denverpost.com/2017/08/25/marijuana-impairment-testing/.

[40] National Highway Traffic Safety Administration (NHTSA), *Drug and Alcohol Crash Risk*, DOT HS 812 440 (Washington, DC: U.S. Department of Transportation, February 2015), 8, https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/812117-drug_and_alcohol_crash_risk.pdf.

[41] NHTSA, 8.

[42] Washington Traffic Safety Commission, *Marijuana Use, Alcohol Use, and Driving in Washington State* (Spokane: Washington Traffic Safety Commission, April 2018), 4, http://wtsc.wa.gov/wp-content/uploads/2018/04/Marijuana-and-Alcohol-Involvement-in-Fatal-Crashes-in-WA_FINAL.pdf.

[43] Migoya, "Traffic Fatalities Linked to Marijuana."

[44] Migoya, "Are You High?"

[45] U.S. Department of Transportation, *Marijuana-Impaired Driving: A Report to Congress*, DOT HS 812 440 (Washington, DC: U.S. Department of Transportation, July 2017), 28, https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812440-marijuana-impaired-driving-report-to-congress.pdf.

levels may not be the optimum measure of marijuana impairment.[46] The result is that any conclusions that can be drawn from data surrounding marijuana use and traffic fatalities in Colorado since legalization six years ago are circumspect, to say the least.

D. RESEARCH DESIGN

This thesis attempts to determine if marijuana legalization saves lives by conducting a case study analysis of the state of Colorado in light of both internal (state policies, regulations, and laws) and external (national drug trafficking trends) factors. The study also examines policies of Uruguay and overall public health trends (traffic safety laws, opioid use, and overdoses) to determine whether any similarities exist in terms of public health impacts of legalized marijuana.

Recent studies indicate that marijuana legalization may have a positive benefit: that opioid addiction and overdose rates are lower in states that have legalized the drug than in states that still treat marijuana as an illegal substance (discussed more fully in Chapter II). I begin by exploring overall opioid addiction and overdose rates, both licit and illicit. I then examine illicit trafficking, and how Mexican drug trafficking groups, in particular, have adapted to legal retail marijuana in Colorado. The public health and safety impact of a surge in much cheaper and purer heroin on the streets of Denver—a reaction by Mexican cartels to marijuana legalization in several U.S. states—is also addressed. Some comparisons are made between the legalization of marijuana in Colorado and Prohibition's repeal in 1933, as both social and economic factors that came into play upon the repeal of Prohibition also exist in the immediate aftermath of marijuana legalization.

The thesis also provides an in-depth examination of the short- and long-term medical impacts of marijuana on both youth and adults. The results are compared with the relative negative impacts of other drugs (both legal and illegal) to identify the overall personal and societal impacts of chronic marijuana use.

Major actors who have shaped public policy on marijuana legalization are analyzed, including elected politicians, voters, pro- and anti-legalization groups, and scientific

[46] U.S. Department of Transportation, 4.

research organizations. This analysis helps determine whether deliberate attempts at shaping medical and analytic research to alter government policy and public opinion are occurring, and then helps prescribe policy changes to address these concerns.

The impact of legal marijuana on driver safety is examined, since driving while under the influence of a hallucinogen can affect reaction times. In addition, outside of the medical causes of death—such as cancer, heart disease, suicides, and household accidents—traffic accidents caused the most deaths in Colorado in 2016.[47] By examining the stakeholders' positions, overall marijuana policies, and public health trends to include suicides, one may determine whether lobbying efforts and their attached biases (for or against legalization) have shaped overall public views on marijuana in Colorado.

To compare Colorado's experience to another area that has legalized marijuana, this thesis examines the experiences of Uruguay. Uruguay legalized marijuana in 2017 (the law was passed in 2013), and already reports indicate that crime rates may have dropped markedly in the first year of legalization.[48] Taking a compare-contrast approach helps determine whether or not the impact of legal marijuana in Colorado is similar to legal marijuana for other political entities.

The data analyzed include open-source, unclassified, peer-reviewed journal articles and reports, as well as periodicals that pertain to the focus area. Government reports, such as opioid overdose historic data from the Centers for Disease Control and Prevention (CDC) and the NHTSA's various reports on marijuana and highway safety are also used. Voting and referendum historical data is considered to show the impact of the cannabis industry's lobbying and advertising campaigns. Trend analysis is used to make projections for future health and public safety impacts of marijuana. Policy recommendations are made

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47 "Death Dataset," CDPHE, accessed July 6, 2018, http://www.cohid.dphe.state.co.us/scripts/htmsql.exe/mortalityPub.hsql.

48 "Crime Rate Drops but Uruguay Struggles with Illicit Sale of Cannabis to Tourists," Telesur, January 13, 2018, https://www.telesurtv.net/english/news/Crime-Rate-Drops-but-Uruguay-Struggles-with-Illicit-Sale-of-Cannabis-to-Tourists-20180113-0015.html.

based upon the concept of *nowcasting*, which identifies major events in the past that will have predictable effects in the next decade.[49]

[49] Rodrigo Nieto-Gomez, "A Director of the Present? Nowcasting Homeland Security's Challenges," *Homeland Security Affairs* (September 2016), https://www.hsaj.org/articles/11952.

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II. OPIOIDS, CARTELS, AND PUBLIC HEALTH IN COLORADO

This chapter examines opioid trafficking and consumption and its effect on the entire Western Hemisphere. From gang violence in Honduras to heroin overdoses on the streets of Cleveland, many lives have been impacted. A close examination of how Mexican cartels have adapted in the past to market forces and law enforcement operations allows projections to be made for current and future organizational changes. Street-level data is analyzed to determine whether Mexican cartels have successfully adapted to marijuana legalization in numerous states. A discussion of how that adaptation has impacted American drug users—along with prescription drug policies and practices—is made. This section concludes with an assertion: that Mexican cartels did not fuel the opioid epidemic; rather, Mexican cartels seemingly took advantage of an increased demand in opioids coupled with a concurrent decrease in marijuana sales due to the growing legalization of marijuana in the United States to saturate the opioid market in the United States.

A. OPIOIDS AND WORLDWIDE PUBLIC HEALTH

One of the underlying claims that marijuana legalization proponents make is that people tend to use drug substitution when marijuana is legal—and avoid harder drugs such as heroin and fentanyl. Before assessing the overall public health impact of legalized marijuana in Colorado, in this section I analyze the overall effects the opioid epidemic is having on Americans—and our neighbors to the south as well. This will ultimately help frame any policy recommendations that can be made after overall trafficking-related data and other public data are analyzed.

The federal government has responded to the opioid crisis in a variety of ways, but many are questioning the results. President Trump "promised to increase law enforcement and strengthen border security to 'beat this disgusting situation' of drug abuse across this country but he did not declare a national public health emergency."[50] Finally, in October

[50] Dan Tuohy, "Trump Opioid Commission: No National Emergency, But Still a Top Priority," New Hampshire Union Leader, August 8, 2017, http://www.unionleader.com/health/Trump-opioid-commission-No-national-emergency-but-still-a-top-priority-08082017.

of 2017 the Trump administration went as far as categorizing the problem as a public health emergency, opening the way for federal grants to be used to combat opioid abuse, hire specialists, enhance requirements for federally licensed opioid prescribers, and launch a new initiative to develop non-addictive painkillers.[51] Despite the announcement of these initiatives, however, very little movement from the federal government on an enhanced campaign against opioid addiction has been noted. For example, the Trump administration made only modest budget increases to the Office of the National Drug Control. In addition, cabinet-level public statements, such as a statement from Health and Human Services Secretary Tom Price which asserted that medication-assisted rehabilitation is simply "substituting one opioid for another," may indicate a fundamental lack of understanding of past policies and programs that worked.[52]

Transnational organized crime groups, including Mexican cartels, are not just a threat to U.S. national security; nation-states throughout the Western Hemisphere are facing violent crime at record-breaking levels. Homicide rates are noticeably higher in source and transit nations in the Western Hemisphere, as shown in Table 3.[53] Note the number of Latin American and Caribbean nations (highlighted in orange) that rank at the top of the entire world for homicide rates. Source and transit nations (those countries that have active production and trafficking of illicit drugs ongoing within their borders) are, year in and year out, the most violent countries in the world, even when compared with countries such as Iraq or Afghanistan that face active insurgencies or post-war infighting.

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[51] Julie Hirschfeld Davis, "Trump Declares Opioid Crisis a 'Health Emergency' but Requests No Funds," *New York Times*, October 26, 2017.

[52] James Reinl, "Trump Administration and the Opioid Epidemic in the USA," *The Lancet* 389, no. 10085 (June 3, 2017): 2181, https://doi.org/10.1016/S0140-6736(17)31543-X.

[53] "Intentional Homicides (per 100,000 people)," World Bank, accessed October 22, 2018, https://data.worldbank.org/indicator/VC.IHR.PSRC.P5?view=map&year_high_desc=true.

Table 3. Homicide Rates—Top 20 Nations[54]

Country	Homicide Rate per 100,000—2016
El Salvador	82.84
Honduras	56.52
Venezuela	56.33
Jamaica	47.01
Belize	37.60
St. Vincent and the Grenadines	36.46
South Africa	33.97
Brazil	29.53
The Bahamas	28.40
Guatemala	27.26
Columbia	25.50
Central African Republic	19.76
Mexico	19.26
Puerto Rico	18.51
Guyana	18.37
Dominican Republic	15.18
Bermuda	12.96
Seychelles	12.74
Costa Rica	11.90
Cabo Verde	11.49

Latin American and Caribbean nations are highlighted in orange.

[54] Adapted from World Bank.

One of the hardest-hit nations in the world in terms of homicides is Mexico. Brianna Rennix and Nathan Robinson state that "in 2017, two countries hit a milestone. In Mexico, there were 29,168 murders, the highest number on record. Across the border in the United States, nearly 70,000 people died from drug overdoses, over three times as many as were dying annually less than two decades ago."[55]

B. OPIOID ADDICTION AND OVERDOSES

Year after year, opioid addiction and overdose rates are going up in the United States. The deaths from licit and illicit opioids are a national security threat. The National Institute on Drug Abuse tracks overdose rates in the United States by a variety of causes. Figures 1 and 2 highlight fatal overdoses due to opioids overall and those due to heroin in recent years.

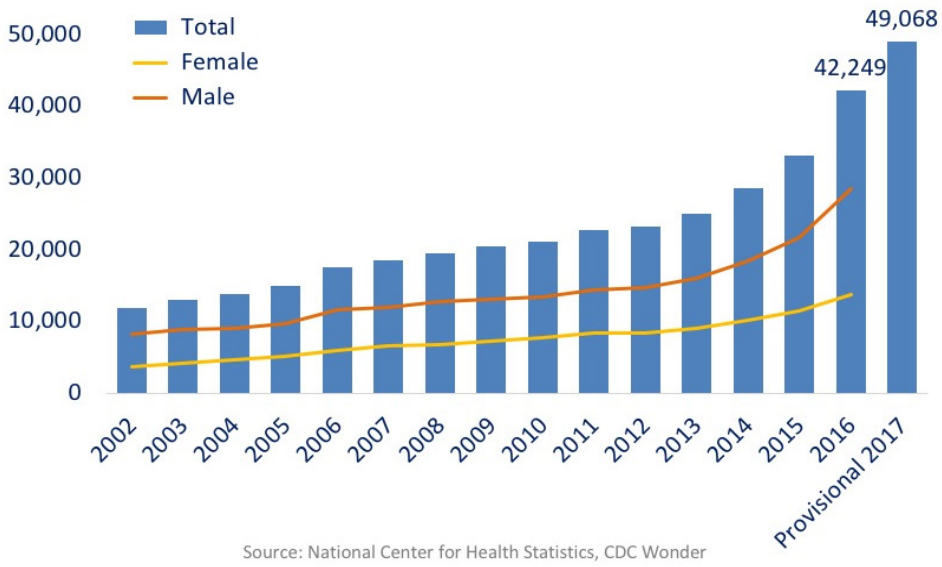

Figure 1. National Overdose Rates, Licit and Illicit Drugs, 2002–2017[56]

[55] Brianna Rennix and Nathan J. Robinson, "Death and the Drug War," *Current Affairs*, June 4, 2018, https://www.currentaffairs.org/2018/06/death-and-the-drug-war/.

[56] Source: National Institute on Drug Abuse, "Overdose Death Rates."

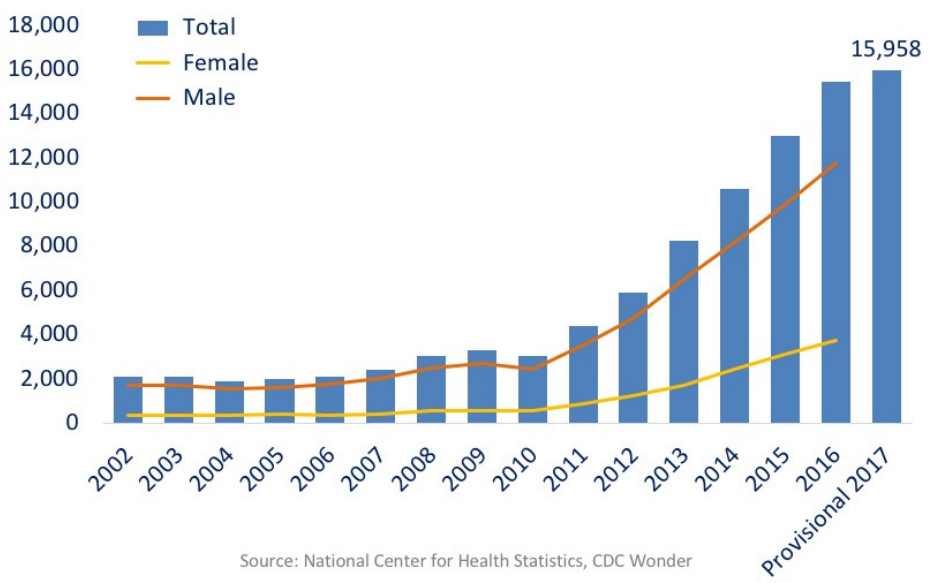

Figure 2. National Heroin Overdose Deaths, 2002–2017[57]

Comparing the 2017 data from Figures 1 and 2, all opioids caused 49,068 deaths while heroin caused 15,958. The increase in overall opioid-related overdose deaths besides heroin, to include an increase in prescription and fentanyl overdose deaths, may have several possible explanations. However, by breaking down the overdose deaths between licit (prescription) and illicit (heroin and fentanyl), one can see the impact each has on American society quite clearly. Prescription opioids in 2017—see Figure 3—involved approximately 19,354 deaths.[58] Note also the trend in the past five years of reporting—relatively flat. However, when one compares overdose deaths due to heroin (15,958—see Figure 2) versus fentanyl and heroin (29,406—see Figure 4) in 2017, approximately 54 percent of illicit opioid overdoses in 2017 were attributed to heroin alone.

[57] Source: National Institute on Drug Abuse.

[58] National Institute on Drug Abuse.

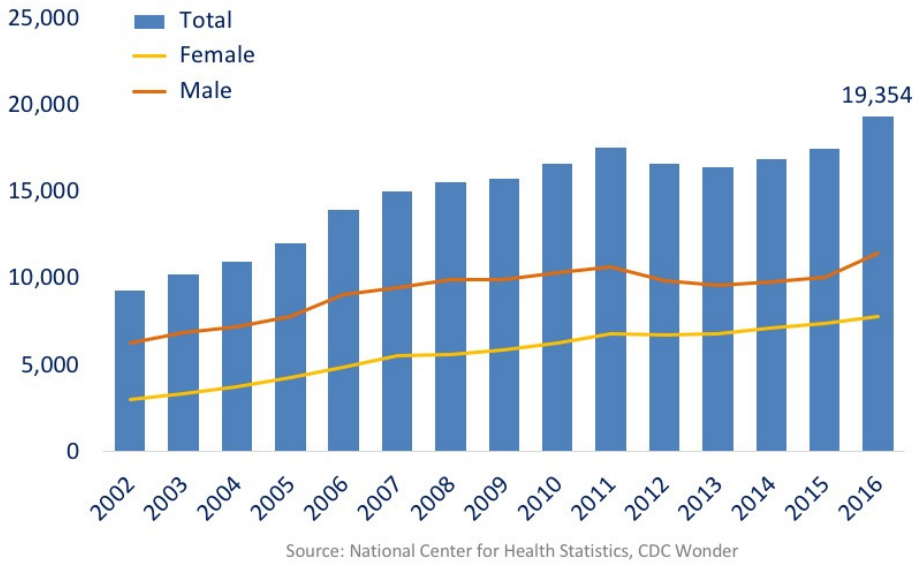

Figure 3. National Opioid Pain Reliever Overdose Deaths, 2002–2016[59]

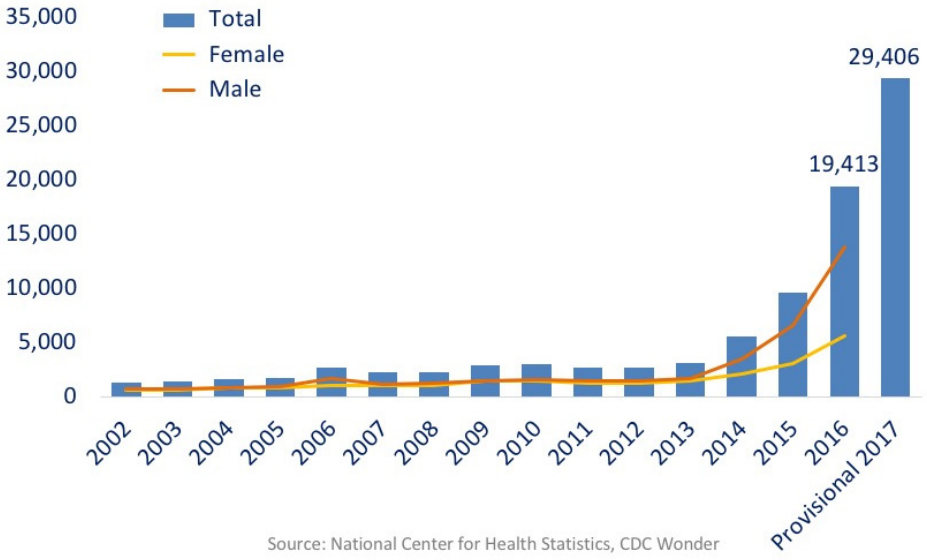

Figure 4. National Synthetic Opioid Overdose Rates (Predominantly Fentanyl), 2002–2017[60]

[59] Source: National Institute on Drug Abuse.

[60] Source: National Institute on Drug Abuse.

The *Annual Review of Public Health* examines opioid prescription practices by medical doctors within the United States. The report cites several landmark events, such as a 1986 paper that concluded *long-term* OPR prescriptions could be administered safely. The 1986 paper was, despite its "low-quality evidence," used frequently thereafter to "support expanded use of opioids for chronic non-cancer pain."[61]

In addition, the 1995 introduction of OxyContin, manufactured by Purdue Pharma, also served as an accelerant that dramatically increased opioid prescriptions.[62] Not content to simply develop OxyContin, Purdue launched an intense marketing blitz for the drug between 1996 and 2002. Through direct sponsorship or grants, the campaign organized more than 20,000 pain-related educational programs, encouraging long-term OPR prescriptions for non-cancer pain. As part of the marketing strategy, Purdue gave funding assistance to the American Academy of Pain Medicine, the Federation of State Medical Boards, and other organizations. In response, these organizations all lobbied for a more aggressive diagnosis and treatment of pain, to include prescribing OPRs. One such group supported by Purdue, the American Pain Society, debuted a campaign entitled "Pain is the Fifth Vital Sign" in 1995. This initiative advocated for health-care professionals to treat pain (and its assessment) just as they do other vital signs, and to prescribe OPRs in response to the pain measurements.[63] Concurrent with this dramatic rise in prescribing opioids to medical patients, prescription opioid sales, overall deaths, and opioid addiction treatment participation rose dramatically from 1999 to 2010 (see Figure 5).[64]

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[61] Kolodny et al., "The Prescription Opioid and Heroin Crisis," 562.

[62] Kolodny et al., 562.

[63] Kolodny et al., 562.

[64] Kolodny et al.

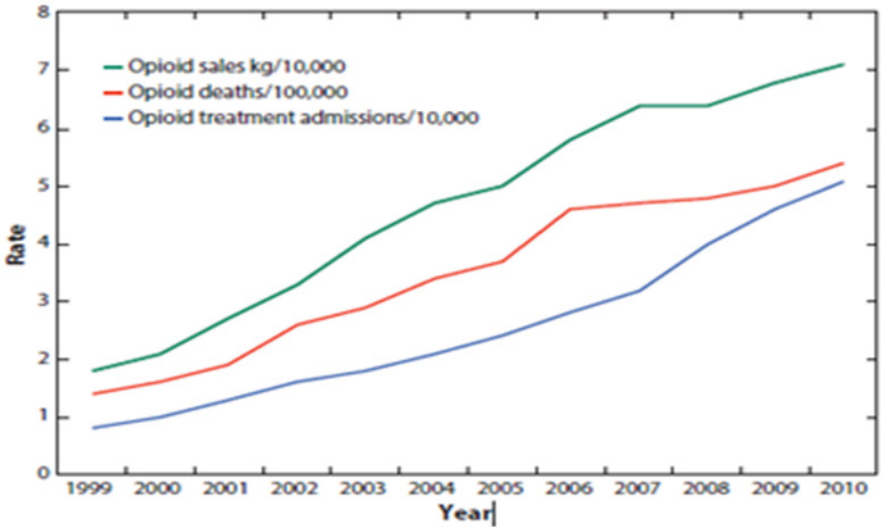

Figure 5. Rates of OPR Sales, Deaths, and Treatment Admissions, 1999–2010[65]

C. OPIOID ABUSE/OVERDOSE RATES IN COLORADO

With some research indicating that states with legalized marijuana have a lower rate of opioid addiction and overdoses, a careful examination of Colorado's rate of overdoses by year is warranted. The Colorado Health Institute reported that, in 2017, overdose fatalities in the state reached another record high, and captured the data shown in Figure 6.[66]

While Colorado is breaking records compared to past overdose rates, how does it compare to other states? Figure 7 is a comparison of five other states that do not have legalized marijuana, during the same time period. Opioid overdose rates in all five states are increasing, but Colorado is increasing at a relatively slower rate than all others except for Wyoming and Minnesota—and Colorado is the only state of those considered that has legalized marijuana.

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[65] Source: Kolodny et al., 560.

[66] Jaclyn Zubrzycki, "Death by Drugs: Colorado Reaches a Record High for Overdose Fatalities. Again," Colorado Health Institute, April 26, 2018, https://www.coloradohealthinstitute.org/research/death-drugs.

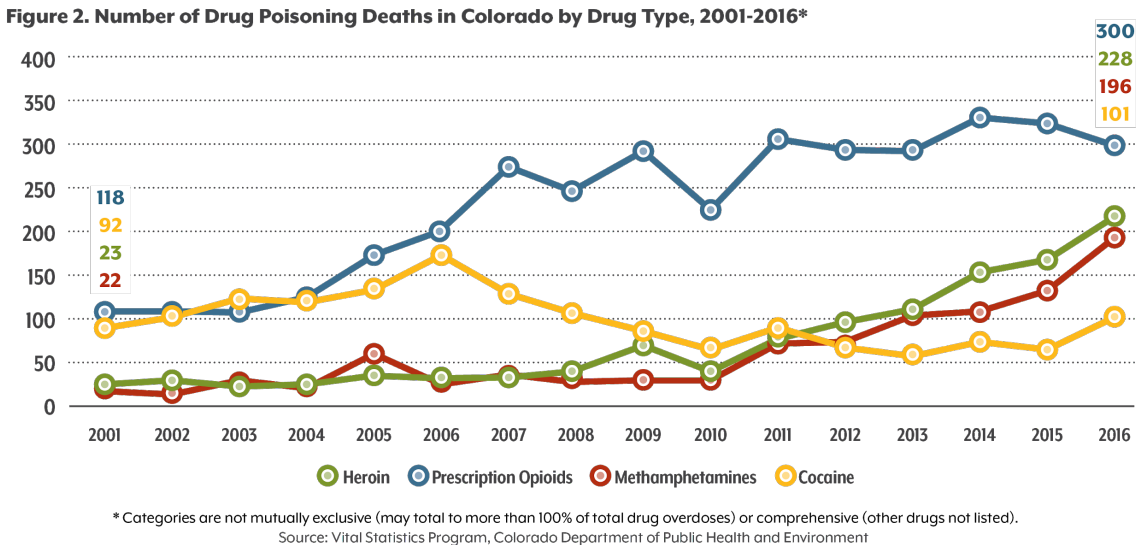

Figure 6. Drug Poisoning Deaths in Colorado by Drug Type, 2001–2016[67]

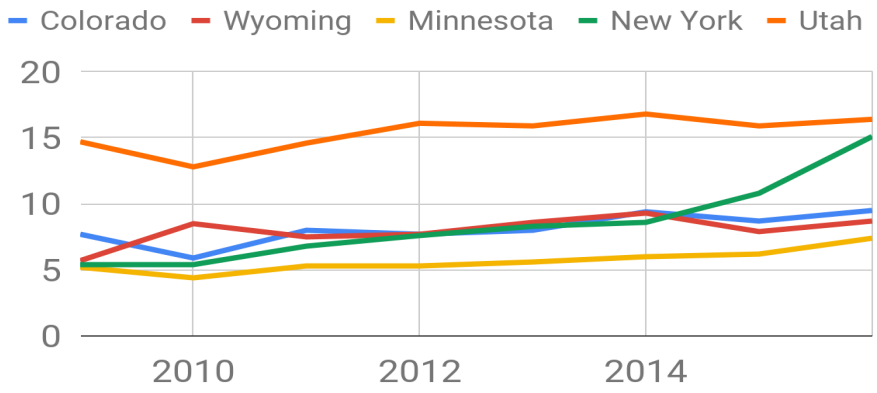

Figure 7. Opioid Overdose Rates by State per 100,000, 2009–2016[68]

How do changes in opioid prescription practices translate into illicit opioid use? The *Annual Review of Public Health* states that the use of medical OPRs for nonmedical use increased in the late 1990s, peaked in 2002 with 2.7 million users, and has since decreased. However, the same report indicates that overdose deaths, drug rehabilitation

[67] Source: Zubrzycki.

[68] Source: "Opioid Summaries by State," National Institute on Drug Abuse, February 2018, https://www.drugabuse.gov/drugs-abuse/opioids/opioid-summaries-by-state.

program admissions, and "other adverse public health outcomes associated with OPR use have increased dramatically since 2002."[69]

In a similar fashion, a 2017 article in the *Clinical Advisor* cites a CDC study that asserts that the number of OPR prescriptions remains high and varies from county to county while the overall number of OPR prescriptions dropped between 2010 and 2015.[70] Specifically, between 2006 and 2015, the peak opioid prescription year was 2010 (782 morphine milligram equivalents [MME] per person) and decreased to 650 MME in 2015. In that same study, the CDC found that the highest-prescribed counties had six times the prescription rates than the lowest-prescribed counties. Although the "agency… found that daily MME per prescription was stable from 2006 and 2010 and then decreased 17% between 2010 and 2015, the CDC notes that the average days' supply per prescription increased 33% from 13 days in 2006 to about 18 days in 2015."[71] Although in recent years the overall national opioid prescription rates have decreased noticeably, the impact of past prescriptions still haunts us to this day as overdose rates continue to increase.

Past opioid prescription practices fueled by marketing campaigns from Big Pharma, coupled with medical endorsements and the transition made by some individuals from prescription to illicit opioids, have caused an increase in demand for both heroin and other illicit opioids.

D. CARTELS AS A THREAT TO NATIONAL SECURITY

In its 2015 *National Military Strategy*, the Department of Defense (DoD) lays out an overall strategy to combat threats, to include programs and operations that support "interagency efforts with Latin American and Caribbean states to promote regional stability and counter organized criminal organizations."[72]

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69 Kolodny et al., "The Prescription Opioid and Heroin Crisis," 563.

70 "CDC: Opioid Prescription Rate Remains High," *The Clinical* 12, http://libproxy.nps.edu/login?url=https://search.proquest.com/docview/1947428885?accountid=12702.

71 "CDC."

72 Joint Chiefs of Staff, *The National Military Strategy of the United States of America* (Washington, DC: Department of Defense, 2015), 9.

In addition to the Pentagon's assessment of transnational criminal organizations being a national security threat, the White House, in 2011, published a comprehensive overview of the impact of transnational organized crime groups as well as a strategy to combat them.[73] In "Transnational Organized Crime: A Growing Threat to National and International Security," the White House asserts that transnational organized crime (TOC) is a major threat with "dire implications for public safety, public health, democratic institutions, and economic stability across the globe."[74] The report cites numerous factors that shape the assertion that TOC is a national security threat, to include:

- Corruption of government institutions
- Economic threats to the United States
- Increase in drug trafficking
- Human smuggling
- Human trafficking
- Weapons trafficking
- Cybercrimes

Renee Novakoff asserts that although TOC networks are not a traditional force-on-force, conventional threat, they are an insidious enemy that readily transcends borders.[75] Citing the Obama administration's publication of the first-ever "Strategy to Combat Transnational Organized Crime," as well as the assessed threat of TOCs in the 2015 *National Security Strategy*, she states that organized crime as a whole, is, in fact, a threat

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[73] National Security Council, "Transnational Organized Crime: A Growing Threat to National and International Security," Obama White House, accessed February 14, 2019, https://obamawhitehouse.archives.gov/administration/eop/nsc/transnational-crime/threat.

[74] National Security Council, "Transnational Organized Crime: A Growing Threat to National and International Security," Obama White House, accessed February 14, 2019, https://obamawhitehouse.archives.gov/administration/eop/nsc/transnational-crime/threat.

[75] Renee Novakoff, "Transnational Organized Crime: An Insidious Threat to U.S. National Security Interests," *Prism* 5, no. 4: 134–49, http://libproxy.nps.edu/login?url=https://search.proquest.com.libproxy.nps.edu/docview/1762303344?accountid=12702.

to national security. She asserts that "it undermines our financial institutions, our laws, and our national morals" and points out that illegal trafficking, a $6 trillion per year industry, earns between $750 billion to $1 trillion through drug trafficking.[76]

Government officials at the national level, within both the DoD and the National Security Council, view TOCs and the opioid crisis as national security threats. Overdose trends and numerical levels point to dramatic increases in heroin deaths. Because of this threat, it is necessary to look closely at Mexican cartels. If Mexican cartels have adapted to the legalization of marijuana in some states by growing, transporting, and selling more addictive, dangerous, and lucrative drugs such as heroin in the United States, then they represent a rising threat to national security.

1. Historic Response by Cartels to Market Changes

Modern-day Mexican cartels have roots that race back to the 1980s, when prominent Colombian cartels used Mexican transportation organizations to move illicit product into North America. Pablo Escobar, the leader of the Medellin cartel in Colombia, sought out a relatively small drug trafficking group in Guadalajara, Mexico, after the cartel's transshipment routes through Florida were blocked by U.S. law enforcement actions.[77] As the Medellin cartel and the transportation group in Guadalajara set up formal business practices through years of joint illicit trafficking, the Guadalajara group began to demand payment in product rather than cash. This flow of illicit drugs (mostly cocaine) allowed the group to expand its own distribution and sales networks within North America, thereby solidifying its own market share.[78] This relatively small *functionally* focused Mexican cartel transformed into the Guadalajara cartel, managing production, transportation, and distribution of drugs.[79]

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[76] Novakoff, 134.

[77] Kelly Hanen, "Doubling Down: Why Mexican Drug Trafficking Organizations Should Be Designated as Foreign Terrorist Organizations and as Significant Narcotics Traffickers," *American Journal of Criminal Law*, 43 (2016): 176–77.

[78] Hanen, 177.

[79] A narcotrafficking entity that focuses on one aspect of the industry: production, transshipment, or sales, for example. Hanen, 177.

The transition of functionally focused trafficking organizations to full-fledged drug trafficking organizations seen in Mexico has happened in other places throughout the world. A group focused initially on guarding coca crops, the Fuerzas Armadas Revolucionarias de Colombia (FARC) made such a transition in the 1990s.[80] As in Mexico, once the enormous profits were made apparent simply by guarding coca cultivation areas for the Medellin and Cali cartels, FARC leadership began to acquire—and dominate—major aspects of the drug trade. This permitted the FARC to become strategically independent, in that it controlled the cultivation, production, and transportation of drugs.[81] This complete strategic independence—achieved by the FARC and other narcotrafficking groups—allows the group to dominate many aspects of drug trafficking (from crops to production to regional distribution). In addition, drug trafficking organizations began branching out into other areas, to include human trafficking, money laundering, extortion, and cybercrimes.[82] This builds financial strength because of diversification and control of many market aspects during financially challenging times, when drug trafficking efforts drop because of successful law enforcement activities or other negative impacts. Other groups, from the Taliban to ISIS to Hezbollah, followed the same trajectory of controlling major functional areas of trafficking coupled with diversification.[83]

What prompts a successful business—even a criminal enterprise—to branch out from a functionally focused group into an entity that dominates the entire market for its targeted geographic region? Robert Kurrle examines business model theories and asserts that most models have two key aspects: capturing value (a product in strong demand) and a means to deliver that value (a logistics infrastructure).[84] Although these requirements

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[80] Gary Leech, *The FARC: The Longest Insurgency* (London: Zed Books, 2011), 61.

[81] Carlos Alberto Ospina Ovalle, "Was FARC Militarily Defeated?," *Small Wars and Insurgencies* 28, no. 3 (2017): 530.

[82] Ovalle, 530.

[83] Ovalle, 530.

[84] Robert W. Kurrle Jr., "The Effective Business Practices of Mexican Drug Trafficking Organizations (DTOs)" (master's thesis, Naval Postgraduate School, 2013), 13.

may sound simple, the fact that cartels have to overcome obstacles put in their path to keep them from operating in the deviant world forces them to be adaptive.[85]

Fully examining the impact of marijuana legalization in Colorado in terms of public health and safety requires a close inspection of the industry that historically produced and distributed marijuana on the black market in Colorado. The maturation—and subsequent market adaptation—of drug trafficking organizations in light of cannabis legalization may have more of an impact on public health in Colorado than marijuana use itself due to its potential to flood the market with cheap illicit opioids.

2. Current Response by Cartels to Market Changes

The maturation of functionally based organizations into corporate narcotrafficking enterprises with a diversified product line has occurred worldwide, including in North America. Business theory models can be applied to these same groups to analyze their actions in light of strong countervailing forces, such as law enforcement operations and the negative public stigma associated with narcotic addiction. By focusing on the value provided—illicit drugs getting to the consumer—and the flexible and resilient nature of the infrastructure to thwart challenges to its market share, Mexican cartels can be better understood.

Through the lens of Kurrle's business model theory, a Mexican cartel is successful only if it provides a drug that is in demand and only if the cartel can deliver it through a reliable infrastructure. A decrease in opioid interdiction within the United States would indicate a resilient infrastructure, as would a decrease in drug trafficking arrests.[86] Increased opium production rates (to offset a degradation in marijuana profits) would indicate "value provided," with the product getting to its intended consumer. In addition, a decrease in street prices for heroin, for example, translates to a greater supply at the local

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[85] Kurrle, 14.

[86] Able to withstand heightened military and law enforcement counterdrug operations as well as market shifts in supply, demand, and domestic legalization.

level."[87] Interdiction rates, production rates, and heroin street prices will be analyzed later in this paper to determine whether Mexican cartels have been successful in light of *retail* marijuana legalization in the United States, since one of their key "values provided" is now produced and distributed by non-cartel entities. Before analyzing trafficking data, however, it is important to examine steps taken by Mexican cartels to adapt to a drug market where government entities now legalize and regulate marijuana, historically one of the main drugs trafficked by these groups.[88] This may help explain recent trends in narcotics trafficking.

Mexican drug cartels challenge national security in both Mexico and the United States. Despite a concerted effort by past Mexican presidential administrations to target cartel leaders and increase direct action (kill or capture) cartel members, Mexican cartels remain the "greatest criminal drug threat to the United States; no other group is currently positioned to challenge them."[89] In addition, the U.S. Drug Enforcement Administration (DEA) assesses that Mexican cartels are using "transportation routes and distribution cells" overseen by cartel members and are consistently examining ways to expand their market penetration into the United States, particularly with heroin.[90] Figure 8 shows the most recent DEA assessment of Mexican TCOs' penetration into the United States via personnel, distribution hubs, and market domination. This increased presence within the United States has enabled Mexican cartels to control wholesale and street-level transportation, distribution, and sales of illicit drugs.

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[87] Tom Gorman and Lindsey Myers, *Heroin in Colorado: Preliminary Assessment* (Aurora: Colorado Consortium for Prescription Drug Abuse Prevention, Heroin Response Work Group 2017), 5.

[88] DEA, *2015 National Drug Threat Assessment Summary*, DEA-DCT-DIR-008-16 (Springfield, VA: DEA, October 2015), 1, https://www.dea.gov/sites/default/files/2018-07/2015%20NDTA%20Report.pdf.

[89] DEA, vi.

[90] DEA, vi.

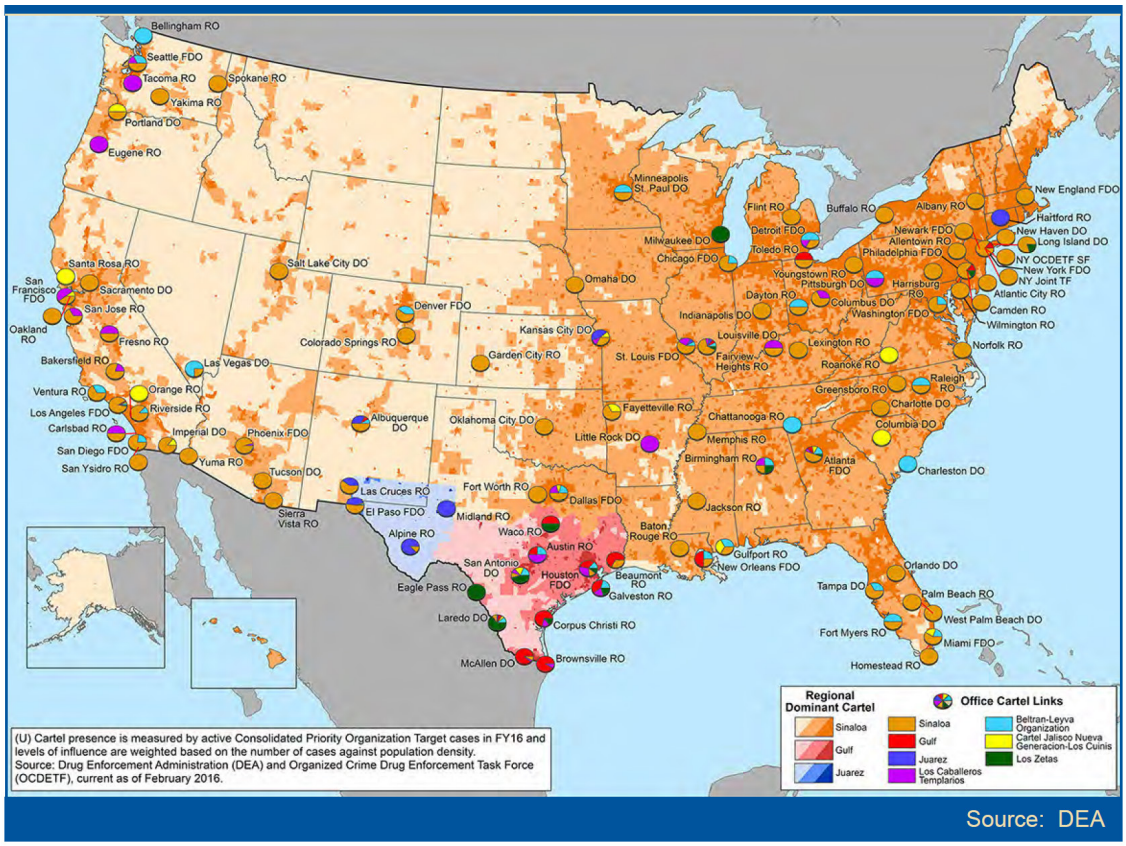

Figure 8. Areas of Influence of Major Mexican TCOs[91]

E. DATA ANALYSIS

Drug trafficking organizations are businesses, focused on maximizing profits and minimizing risks. Using business model theory, the analysis of both the value provided (illicit drugs getting to the consumer) and the flexible and resilient nature of the infrastructure will indicate whether Mexican cartels are currently adapting to market changes within U.S. drug consumption habits. Simply put, if trafficking arrests, interdiction rates, and street values of heroin drop or remain constant, coupled with a concurrent rise in heroin production and market penetration, then Mexican cartels may have rebounded from

91 Source: DEA, 1.

marijuana legalization by successfully trafficking larger quantities of a more lethal substance.[92]

1. Heroin-Related Arrests and Overall Domestic Interdiction Rates

If an illicit-goods trafficking business is successful, it will exhibit a resilient and flexible transportation system for its product that avoids law enforcement interference. Additionally, it will not only attempt to keep its personnel out of prison but will also try to keep its products from being confiscated. Using data that the DEA provided to the Congressional Resource Service and the United Nations Office on Drugs and Crime (UNODC) Drug Seizures Database, Figure 9 illustrates heroin-related arrests for conspiracy, distribution, possession with intent, and simple possession, as well as interdiction trends for heroin within the United States.

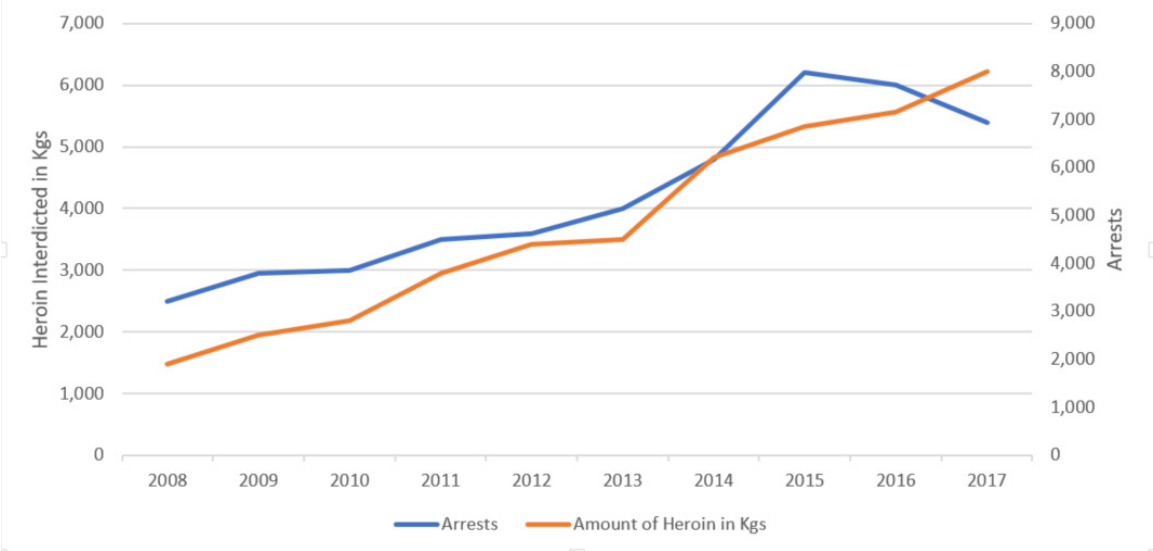

Figure 9. U.S. Heroin-Related Arrests and Interdiction Rates, 2008–2017[93]

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[92] DEA, *National Heroin Threat Assessment Summary—Updated*, DEA-DCT-DIR-031-16 (Springfield, VA: DEA, June 2016), https://www.hsdl.org/?view&did=793973.

[93] Source: Kristin Finklea, *Heroin Trafficking in the United States*, CRS Report No. R44599 (Washington, DC: Congressional Research Service, 2017), https://fas.org/sgp/crs/misc/R44599.pdf.

From an arrest perspective, there is a noticeable, consistent rise in heroin-related arrests through 2015, and then a steady decline in the last two years of reporting. This may indicate growing resilience by Mexican cartels as they evade law enforcement operations even though production amounts are increasing. Other contributing factors might include changing law enforcement priorities during the period analyzed or staff cuts. From the interdiction side, the positive trend may indicate several factors: an increase in supply, which thereby increases the footprint of traffickers (and, consequently, the chance that a transshipment will be interdicted), or a degradation in the resiliency of the trafficking networks to get the product to the consumer.

2. Price and Production Rates

A decrease in the street value of heroin would indicate ample supply as well as a relatively secure distribution system.[94] The DEA's Domestic Monitor Program utilizes data obtained from undercover purchases of heroin throughout the United States to monitor street-level prices.[95] In addition, a resilient and flexible Mexican cartel would adjust its product line in light of marijuana legalization in the United States. The UNODC analyzes opium production rates by point of origin. Although the data does not reflect heroin specifically, opium production, as the primary precursor for heroin, is a good indicator of overall heroin production—see Figure 10 for details.[96]

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[94] DEA, *The 2016 National Drug Threat Assessment Summary*, DEA-DCT-DIR-001-17 (Washington, DC: Department of Justice, November 2016), 42, https://www.dea.gov/sites/default/files/2018-07/DIR-001-17_2016_NDTA_Summary.pdf.

[95] DEA, *Heroin Signature Program*, 5.

[96] United Nations Office on Drugs and Crime, *Targeting Precursors Used in Heroin Manufacture* (Vienna, Austria: United Nations Printing Office, November 2008), 3, https://www.unodc.org/documents/afghanistan/Rainbow_Strategy/Red_paper_6_Jan._2012.pdf.

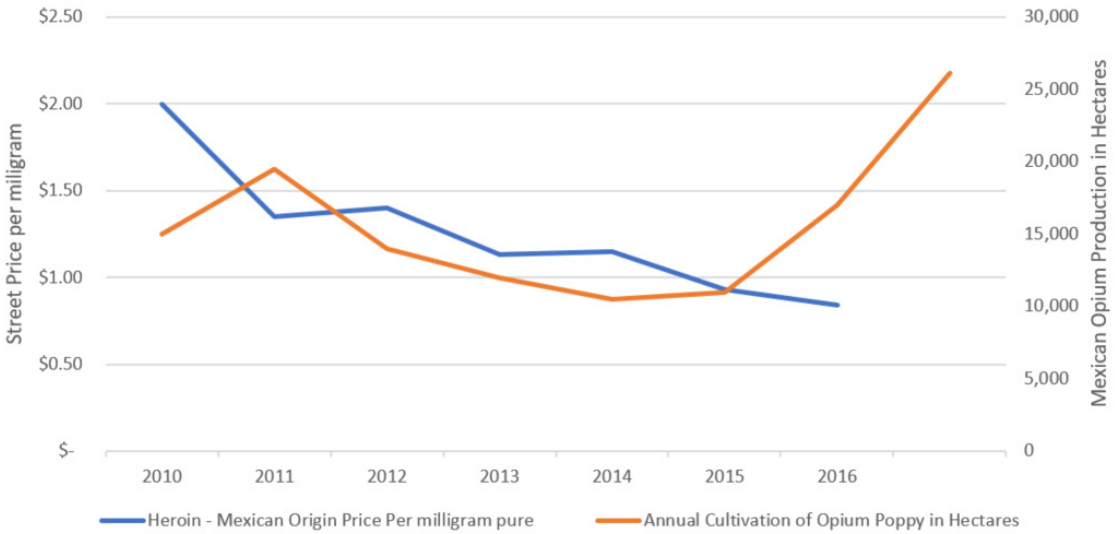

Figure 10. Street Price of Mexican Heroin/Annual Mexican Opium Production, 2010–2016[97]

Market penetration by a business is an indicator that the business is providing value to the customer and that the business has a resilient infrastructure for delivering the product. By analyzing the source of origin of heroin purchased in undercover operations, the DEA's Heroin Signature Program has been monitoring production origins via chemical analysis since 1977. If Mexican cartels successfully counter the legalization of marijuana, then an increased market share of heroin within the United States would follow as the cartel attempts to adjust for its profit loss in illicit marijuana trafficking; see Figure 11 for a graphical depiction of market share increases.

97 DEA, *The Heroin Signature Program and Heroin Domestic Monitor Program 2016 Reports*, DEA-DCW-DIR-026-18 (Washington, DC: Government Printing Office, 2018), https://www.dea.gov/sites/default/files/2018-10/Heroin%20Domestic%20Monitor%20Report%20DEA-GOV%20FINAL.pdf; United Nations Office on Drugs and Crime, *World Drug Report 2018: Global Overview of Drug Demand and Supply*, No. E.18.XI.9 (Vienna, Austria: United Nations Printing Office, 2018), https://www.unodc.org/wdr2018/prelaunch/WDR18_Booklet_2_GLOBAL.pdf.

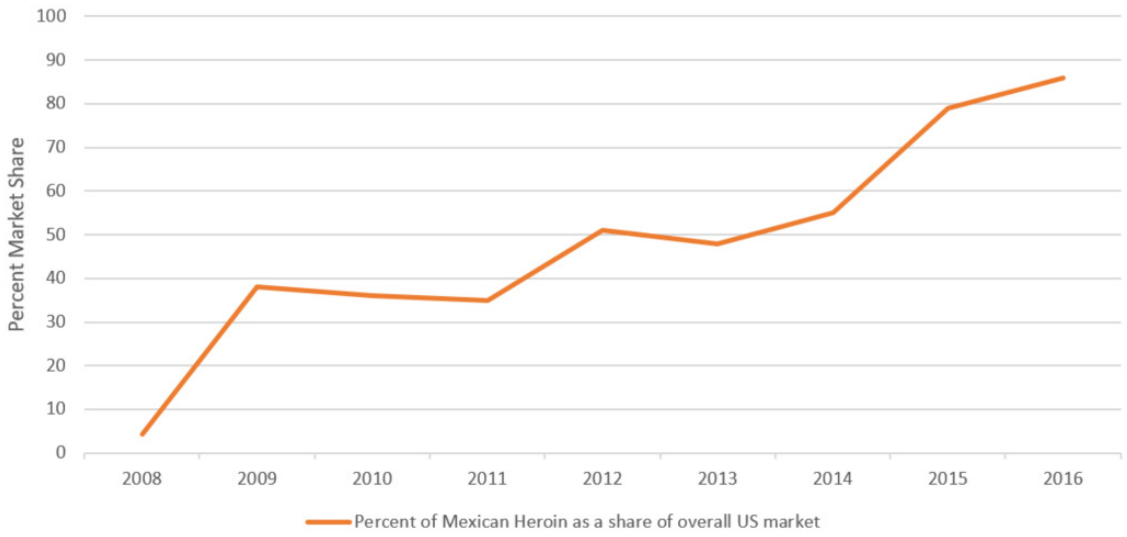

Figure 11. Mexican Heroin, Percent of U.S. Market Share, 2008–2016[98]

In addition, competing TOCs in Asia have witnessed a noticeable decrease in sales within the United States. As an example, in 2012, only 8 of 699 heroin samples obtained during undercover street-level purchases by the DEA were traced back to southwest Asia and, for the eighth consecutive year (2005–2012), no southeast Asia samples were purchased.[99] At a national level, heroin overdose deaths are increasing dramatically; coupled with increased market penetration of the overall heroin market, this signals an adaptive business strategy.

Examining the data presented above in light of when U.S. states adopted medical marijuana laws or retail marijuana laws, it is evident that four out of five markers of a successful adaptation exist. Specifically, heroin prices have decreased, heroin-related arrests are trending downward, Mexican cartel heroin production has increased, and Mexican heroin market shares have increased. However, the reviewed data does not indicate *specifically* that Mexican cartels have become more resilient in terms of avoiding

98 Source: DEA, *Heroin Signature Program 2014*.

99 DEA, *2013 Heroin Domestic Monitor Program*, DEA-DCW-DIR-059-15 (Springfield, VA: DEA, September 2015), 1, https://ndews.umd.edu/sites/ndews.umd.edu/files/pubs/2013%20Heroin%20Domestic%20Monitor%20Program.pdf.

arrests due to operational changes. Better operational security by the cartels may be one factor at play, but state marijuana legalization and other factors may be impacting this data point. In terms of public health impacts for American citizens, these changes are not positive. A cheaper version of an already highly addictive lethal product, with "corporate" personnel in every major city in America, indicates that Mexican cartels are here for the long run.

In addition, the increase in prescription opioid sales over the past two decades, coupled with the transition for many users from licit to illicit opioids as their prescriptions expired, have also contributed to a growing demand for Mexican heroin, thus playing into Mexican cartels' desires to increase profits.

Published estimates of the number of prescription opioid users that ultimately become addicted to opioids vary greatly, from 1 to 26 percent. In their oft-cited study, Nora Volkow and Thomas McLellan purport that the variance could be due to definitions; for example, diagnosed addictions average less than 8 percent while rates of "misuse, abuse, and addiction-related aberrant behaviors have ranged from 15 to 26 percent."[100] Volkow and McLellan assert that 4 percent of Americans addicted to prescription opioids transition to heroin … and this number is growing.[101] Even with a 4-percent transition from prescription opioids to heroin, the market demand is strong, considering the amount of opioids that are prescribed each year. For example, during a two-year study, four percent of the 285,000 non-surgical patients prescribed OPRs reportedly transitioned to heroin each year.[102]

Taking into account the market changes from the licit and illicit supply sides, Mexican cartels are profiting more and more each year. This is not to say that Mexican cartels *fueled* the opioid epidemic; rather, it appears that Mexican cartels took advantage

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[100] Nora D. Volkow and A. Thomas McLellan, "Opioid Abuse in Chronic Pain—Misconceptions and Mitigation Strategies," *New England Journal of Medicine* 374, no. 1253-63 (2016): 1259, https://doi.org/10.1056/NEJMra1507771.

[101] Volkow and McLellan, 1259.

[102] Kolodny et al., "The Prescription Opioid and Heroin Crisis ," 563.

of increased demand in opioids coupled with a concurrent decrease in marijuana sales due to the growing legalization of marijuana in the United States

F. CONCLUSION

Although anecdotal reporting suggests that marijuana legalization in the United States negatively affects Mexican cartels, data can support the idea that such businesses have changed product lines based on market changes. Concurrent with this market change, Mexican cartels have preyed upon American citizens with increased production of a more addictive and lethal drug. Americans are transitioning from prescription opioids to illicit substitutes as their prescriptions expire or because the cost of black market prescription painkillers is much higher than relatively cheap heroin.

Therefore, Mexican cartels have, in part, adapted to market changes that include the legalization of marijuana in some U.S. states and the latent effect of past U.S. opioid prescription practices—and all that entails, to include taking advantage of transitioning users from licit to illicit sources. In the short term, the U.S. heroin market is being flooded by a cheap and highly pure product that continues to kill Americans at an alarming rate.

III. MARIJUANA LEGALIZATION AND THE END OF PROHIBITION: SIMILAR PATHS TO DECREASED VIOLENCE?

A. THE PROHIBITION ERA AND ITS AFTERMATH

The repeal of Prohibition had a large impact on overall crime rates in America; the same effects may take place with the legalization of marijuana in numerous states. The national prohibition of alcohol occurred between 1920 and 1933. Mark Thornton states that this policy was enacted to "reduce crime and corruption, solve social problems, reduce the tax burden created by prisons and poorhouses, and improve health and hygiene in America."[103] He goes on to discuss the Iron Law of Prohibition, which describes how legal suppression of a substance such as alcohol or drugs can lead to *increased* use and more potent variations of the now-illicit substance.[104] These findings—that legalization, rather than prohibition, may have a positive impact on public health—may have implications for marijuana legalization in the United States just as it did for alcohol.

During Prohibition, there was an initial drop in overall alcohol use followed by a consistent rise throughout the remaining years. Thornton posits that innovative entrepreneurs, using the black market, slowly adapt to the new legal reality and expand output, while concurrently consumers begin to rebel against the ban.[105] The Iron Law of Prohibition kicked in as illicit producers—and consumers—embraced more potent forms of alcohol, particularly distilled spirits and fortified wines. Because beer was relatively bulky to produce, the overall price shot up (as compared to pre-Prohibition prices) by 700 percent, while distilled spirits increased in price by 270 percent. The net effect of this was to increase sales of distilled spirits at the expense of beer consumption. From a production perspective, amateurs controlled output and quality control was lacking to the point that some products could harm or kill the consumer.[106]

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[103] Mark Thornton, "Policy Analysis No. 157: Alcohol Prohibition Was a Failure" (policy analysis, CATO Institute, 1991), 1, https://object.cato.org/pubs/pas/pa157.pdf.

[104] Thornton, 2.

[105] Thornton.

[106] Thornton, 4.

The expected drop in crime rates, as anticipated by Prohibition supporters, did not occur due to the transition of a once-legal product into the black market world. Seth Harp asserts that a common cycle occurs in such cases: when a recreational drug is outlawed, legitimate businesses lose out to black market entrepreneurs in terms of money and power. The government then attempts to thwart the criminals, who resist and adapt. Financial transactions take place outside of legal institutions without legal recourse for aggrieved individuals, "leaving violence as the only mechanism for adjudicating contractual disputes and enforcing industry norms."[107] The reality, in this case, was that overall crime rates increased throughout Prohibition, with national homicide rates increasing from 6 per 100,000 prior to Prohibition to 10 per 100,000 in 1933. Prohibition also resulted in an explosion of prisoner levels yet unseen in America; Thornton states that prior to Prohibition, there were 4,000 federal convicts while at the height of Prohibition (1932) the number increased by 562 percent, to 26,589.[108]

In sum, Prohibition did not solve the problems it was intended to solve—specifically, overall crime and alcohol consumption. The exact opposite actually occurred: increased alcohol use after an initial decrease, more potent forms of the banned substance, and an explosion in incarcerated Americans. From a purely public health perspective, Prohibition increased the amount of alcohol use by a segment of the population that it was actually supposed to decrease: young people. In particular, Thornton posits that the illegality of alcohol itself, and therefore the perceived glamour of the product, enticed young Americans to imbibe at an increased rate. Finally, a noticeable reduction in crime, to include organized crime and corruption, was reported after 1933.[109] Repeal of Prohibition "dramatically reduced crime, including organized crime, and corruption" and while "new voluntary efforts, such as Alcoholics Anonymous… succeeded in helping

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[107] Seth Harp, "Globalization and the U.S. Black Market: Prohibition, the War on Drugs, and the Case of Mexico," *New York University Law Review* 85, no. 5 (November 2010): 4, http://search.proquest.com/docview/851780179/.

[108] Thornton, "Alcohol Prohibition Was a Failure," 6.

[109] Thornton, 4.

alcoholics."[110] The overnight legalization of alcohol through the Eighteenth Amendment to the Constitution had long-lasting positive effects on the overall public health of Americans, including decreased consumption by youths use as well as less crime, particularly organized crime.

B. LESSONS APPLICABLE TO MARIJUANA LEGALIZATION

What lessons can be learned from America's experience with Prohibition as it pertains to the legalization of marijuana? Given that the products themselves are very different—the bulkiness of beer versus distilled spirits as compared to the size and potency of a pound of marijuana (which remains relatively unchanged whether it is grown legally or illegally, or depending upon its THC level)—makes for a difficult comparison between the two drugs. However, some similarities can be addressed, to include crime rates and youth use. The Iron Law of Prohibition can be examined in the state of Colorado as it pertains to the legalization of marijuana. In particular, if the long-term stance of federal, state, and local governments on the illegality of marijuana is seen as a prolonged Prohibition, and the 2013 legalization of marijuana as a repeal, similarities can be made. Specifically, one would expect a decrease in marijuana-related crime rates to follow legalization—and this is exactly what is happening in Colorado. An October 2018 report from the Colorado Division of Criminal Justice examined marijuana-related crime in Denver from 2012 to 2017. The data indicate that, with very few exceptions, both marijuana industry and non-industry crime did fall between 2012 and 2017 in the state's largest metropolitan region; see Table 4 for more details.[111] In addition to a drop in overall marijuana-related crime, one expectation of those opposed to legalization of marijuana never truly materialized: since the industry is largely cash-only as of 2018, an increase in robberies was expected but did not occur.[112]

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110 Thornton, 8.

111 Jack K. Reed, "Impacts of Marijuana Legalization in Colorado: A Report Pursuant to Senate Bill 13–283" (report, Colorado Division of Criminal Justice, October 2018), http://cdpsdocs.state.co.us/ors/docs/reports/2018-sb-13-283_report.pdf.

112 Reed, 31.

Table 4. Marijuana Crime in Denver, 2012–2017[113]

	2012	2013	2014	2015	2016	2017
Industry						
Robbery	2	4	7	5	3	6
Aggravated assault	1	0	0	1	0	0
Other person	3	7	8	3	0	3
Burglary	134	102	114	117	170	80
Theft	14	14	24	26	19	17
Trespassing	1	2	2	4	3	4
Criminal mischief	20	19	14	14	10	12
Forgery/fraud	0	1	1	1	2	3
Arson	1	0	0	1	1	0
Drug	0	1	1	11	6	2
Other	1	4	2	3	0	8
Total	177	154	173	186	214	135
Non-industry						
Robbery	19	20	27	23	17	14
Aggravated assault	3	6	5	3	6	1
Other person	1	4	7	8	2	7
Burglary	17	30	39	20	22	19
Theft	10	12	19	15	8	4
Trespassing	1	1	1	0	1	0
Criminal mischief	1	3	0	0	2	1
Forgery/fraud	0	0	0	0	0	0
Arson	0	0	0	0	0	1
Drug	1	1	3	1	1	1
Other	0	3	2	2	0	0
Total	53	80	103	72	59	48
Total						
Robbery	21	24	34	28	20	20
Aggravated assault	4	6	5	4	6	1
Other person	4	11	15	11	2	10
Burglary	151	132	153	137	192	99
Theft	24	26	43	41	27	21
Trespassing	2	3	3	4	4	4
Criminal mischief	21	22	14	14	12	13
Forgery/fraud	0	1	1	1	2	3
Arson	1	0	0	1	1	1
Drug	1	2	4	12	7	3
Other	1	7	4	5	0	8
Total	230	234	276	258	273	183
Total criminal offenses in Denver	NA	NA	61,276	64,317	65,368	66,000

Source: Denver Open Data Catalog, Crime Marijuana, at https://www.denvergov.org/opendata/dataset/city-and-county-of-denver-crime-marijuana. Retrieved 6/6/2018; updated by source 2/27/2018. Denver Police Department Crime Statistics. https://www.denvergov.org/content/denvergov/en/police-department/crime-information/crime-statistics-maps/crime-statistics-archives.html

Examining Thornton's Iron Law of Prohibition from the potency angle, one would expect to find the quality of marijuana, or THC levels, to increase after legalization. Prior

[113] Source: Reed, 32.

to the legalization of marijuana, Bill Briggs states that THC levels were generally below 10 percent; recent testing indicates potency rates as high as 30 percent or more, with an average of 18.7 percent.[114]

As the legitimate market continues to mature, it is expected that the overall quality of licit marijuana will improve. This is directly in line with the repeal of Prohibition and how the quality of alcohol improved in a legal, regulated market. The marijuana industry in Colorado is showing indications of *branding*, which means that certified growers and distributors are making a name for themselves, establishing market share, and advertising openly. Just as in other industries, critics have sprung up. From reviews of marijuana tourist trips to critiques of different weed strains, these professional critics indicate a stable, market-based permanence for many of Colorado's distributors and producers.[115] It is this market branding, and the response by consumers and business critics alike, that indicates permanence and stability in the overall industry.

Finally, one would expect a decrease in marijuana use by Colorado teens since legalization, according to the argument presented by Briggs: legalization should decrease the glamour and danger of use. This is, in fact, what has occurred; see the National Survey on Drug Use and Health's data portrayed in Figure 12.

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[114] Bill Briggs, "Colorado Marijuana Study Finds Legal Weed Contains Potent THC Levels," NBC News, March 23, 2015, https://marijuanaharmlessthinkagain.org/wp-content/uploads/2014/04/Colorado-Marijuana-Study-Finds-Legal-Weed-Contains-Potent-THC-Levels.pdf.

[115] See https://www.denverpost.com/news/marijuana/; https://www.coloradopotguide.com/colorado-marijuana-blog/article/the-top-cannabis-strains-to-enjoy-during-the-fall-season/#comments.

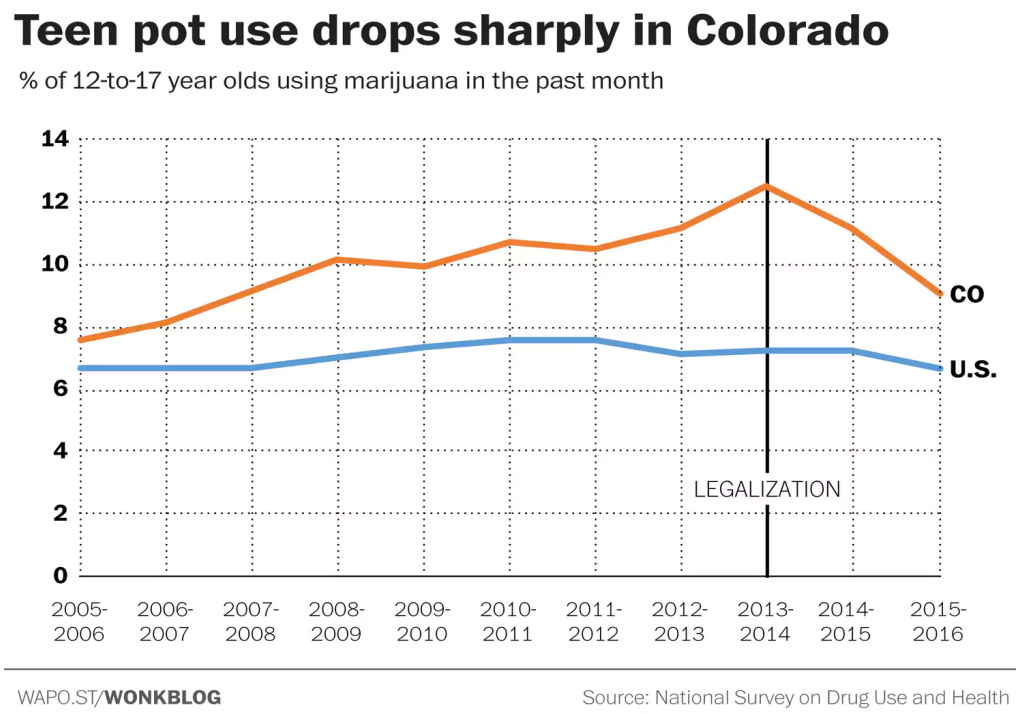

Figure 12. Teenage Marijuana Use by Year, 2005–2016[116]

What impact on citizens' public health has occurred due to the higher marijuana potencies? In a landmark 2014 study, Howard Kim et al. examined emergency department (ED) visits at a major hospital in Aurora, Colorado. The hospital reported annual data just prior to and immediately following marijuana legalization, and generally experiences 100,000 ED visits a year. Only ICD-9 (International Classification of Diseases, Ninth Revision) codes were examined, which covered all cannabis-related ED events. Overall, there was no significant change between 2013 and 2014 for ED visits by Colorado residents, while visits by out-of-state tourists for ICD-9 codes more than doubled.[117] Kim et al. theorize that the difference between in-state and out-of-state ED visits may be due to

116 Source: Christopher Ingraham, "Following Marijuana Legalization, Teen Drug Use Is Down in Colorado," *Washington Post*, December 11, 2017, www.washingtonpost.com/news/wonk/wp/2017/12/11/following-marijuana-legalization-teen-drug-use-is-down-in-colorado/?noredirect=on&utm_term=.380b9ec41853.

117 Howard S. Kim et al., "Marijuana Tourism and Emergency Department Visits in Colorado," *New England Journal of Medicine* 374, no. 8 (February 2016): 797, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4878119/.

the fact that the "initial educational efforts through mass media have focused primarily on Colorado residents."[118]

The comparison between the repeal of Prohibition and the legalization of marijuana in Colorado highlights the difficulties in comparing decades-old data and simple snapshots immediately after legalization. Thornton's Iron Law of Prohibition translates accurately to Colorado's experience with legalized marijuana, at least in the short term. Overall marijuana-related crime has dropped significantly; youth use has dropped and the quality of the product has improved with government regulation and market branding.

Finally, evidence suggests that the legalization of marijuana frees up law enforcement agencies to focus more on violent crime. Long purported to be a benefit of legalization by pro-marijuana lobbying groups, there is limited research on the relationship between marijuana legalization and a police agency's ability to shift its focus to other offenses.[119] A study by David Makin et al., filling the gap in the analysis, focused on Washington and Colorado since legalization and concluded that clearance rates (crimes solved) are, in fact, increasing. Specifically, they found that Colorado's clearance rates for all crime types grew more than in any other state, except for when it came to aggravated assault and motor vehicle theft. In addition, in Washington and Colorado, marijuana legalization showed no negative impact on clearance rates for all crime types.[120] Exactly how this impacts overall public health in Colorado is difficult to ascertain, but if more killers are taken off the street, for example, then legalization, at least from this perspective, is positive.

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[118] Kim et al., 798.

[119] David A. Makin et al., "Marijuana Legalization and Crime Clearance Rate: Testing Proponent Assertions in Colorado and Washington State," *Police Quarterly* 22, no. 1 (July 2018): 2, https://doi.org/10.1177/1098611118786255.

[120] Makin et al., 17.

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IV. MARIJUANA USE AND SCIENCE

When considering the harm done to the user, most research agrees that the later in life you begin to use marijuana, the less impact it will have on your cognitive capabilities. Considering the overall effect on the user and those around him or her, cannabis may have less of a negative impact than do legal drugs such as tobacco and alcohol.

A. COGNITIVE DECLINE IN YOUTH-ONSET MARIJUANA USERS

Overall marijuana use by adults is up in Colorado since legalization—13.6 percent in 2016 versus 15.5 percent in 2017, according to the Colorado Department of Health and the Environment (CDPHE).[121] CDPHE captured data via a telephone survey aimed at residents ages eighteen and older and focused on the causes of chronic diseases, drug use, and disability.[122] Telephone surveys such as the one utilized for CDPHE might be susceptible to under-reporting, especially in the years prior to legalization. Because of this, a definitive number of adult users by year is difficult to ascertain.

What are the long-term impacts on the human body after years of marijuana use? Madeline Meier et al. tracked over 1,000 subjects from age thirteen through age thirty-eight; they collected data on the subjects' initial neuropsychological test at age thirteen and periodic samplings of marijuana use between the ages of eighteen and thirty-eight.[123] The research was controlled by recognizing and eliminating such cofounders as schizophrenia, alcohol, nicotine, or hard-drug dependence. With these controls in mind, the study indicates that test subjects who reported persistent cannabis dependence showed greater IQ decline than those who reported less cannabis use (or none at all). Those who reported never having

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[121] Mark Salley, Marijuana Use in Colorado Rises for Adults, Stays the Same for Kids," Colorado Department of Health and the Environment, July 19, 2018, https://www.colorado.gov/pacific/cdphe/marijuana-use-2017.

[122] See https://www.colorado.gov/pacific/cdphe/behaviorsurvey.

[123] Meier et al., "Cannabis Use and Neuropsychological Decline."

used cannabis had a slight increase in IQ. Those people categorized as "persistent cannabis dependent" had a loss of IQ from 99.68 to 93.93.[124]

In addition, Meier et al. reported that cannabis users receive less schooling than nonusers and that remaining in school may boost a user's IQ.[125] The study also compared adolescent-onset cannabis users to adult-onset cannabis users; adolescent-onset users had a sharper decline in IQ than those who began using as adults. Meier et al. noted no IQ decline in test subjects who began use in adulthood. These effects of marijuana use are noticeable for those currently (or recently) using marijuana. What about users who abstain after years and years of use? What are the lasting effects of marijuana use? Using the same test sample as for IQ deficiencies, Meier et al. concluded that adolescent-onset cannabis users who abstained for one or more years showed a continued neuropsychological deficit, asserting that the findings indicate adolescent cannabis use may have neurotoxic effects on the developing brain.[126]

The assessment that cannabis use in children can have a lasting, permanent impact on neuropsychological performance is not without criticism; the limitations on this report include the possibility of processes (cannabis use, lower education levels, poor academic performance, neuropsychological performance) being interrelated and that cannabis use data were self-reported, with no external controls.[127] How does the impact of cannabis use on public health compare to other legal and illegal drugs? The next section compares the impact of marijuana to other drugs.

B. MARIJUANA USE COMPARED TO OTHER DRUGS

In a groundbreaking book on drug classifications and the overall harm that licit and illicit drugs can do to the human body, David Nutt introduces a sixteen-point methodology

[124] Meier et al., 5.

[125] Meier et al., 5.

[126] Meier et al., 5.

[127] Meier et al., 6.

to determine the relative safety of a drug.[128] Motivated by frustrations borne out of the perceived disparity between the United Kingdom's classification of drugs and statistical research, Nutt utilized multi-criteria decision analysis (weighting of different categories based upon their relative impact) and a panel of experts to evaluate twenty drugs. See Table 5 for a list of factors considered by the panel.

Table 5. Drug Harm Categories[129]

Harms to Users	**Harms to Others**
Drug-specific mortality	Injury
Drug-related mortality	Crime
Drug-specific harm	Economic Cost
Drug-related harm	Impact on family life
Dependence	International damage
Drug-specific impairment of mental functioning	Environmental damage
Drug-related impairment of mental functioning	Decline in reputation of the community
Loss of tangibles	
Loss of relationships	

[128] David Nutt, *Drugs: Without the Hot Air: Minimising the Harms of Legal and Illegal Drugs*, Kindle edition (London: UIT Cambridge, 2012).

[129] Adapted from Nutt, loc 881–921, 928.

Once a weighted score was applied to twenty different legal and illegal drugs, the results indicated that several legal drugs are more harmful overall to the user and those around him or her than many illicit drugs. Nutt, in examining the scoring, points out the dangers of alcohol, especially to those surrounding the user.[130] There were four limitations noted to the study:

1. Only the harm done by a drug was scored, not benefits. Initially, drugs seem to benefit the user; otherwise the user would not take them. Communities also benefit from legal drugs due to jobs and tax revenue.

2. The study did not take into account the harm done due to the drugs' availability and legal status; for example, heroin is more dangerous due to users not being able to get a "clean and constant supply." Therefore, the overall score for heroin might change if a safe, regulated supply of the drug were to be used.

3. "Most people are polydrug users," and this study did not take into account the almost synergistic (and deadly) effect that mixing drugs like alcohol and heroin can have on the human body.

4. Users are "far from being a homogeneous group … a future model might be able to distinguish between prescription and non-prescription users and between addicts and non-addicts"[131]

Taking into account the physical and psychological damage a drug can cause to the user, to his or her family members, and to the community overall, Nutt concluded that cannabis is less harmful than tobacco and much less harmful than alcohol (see Figure 13).

[130] Nutt, loc 1051.

[131] Nutt, loc 1059–1072.

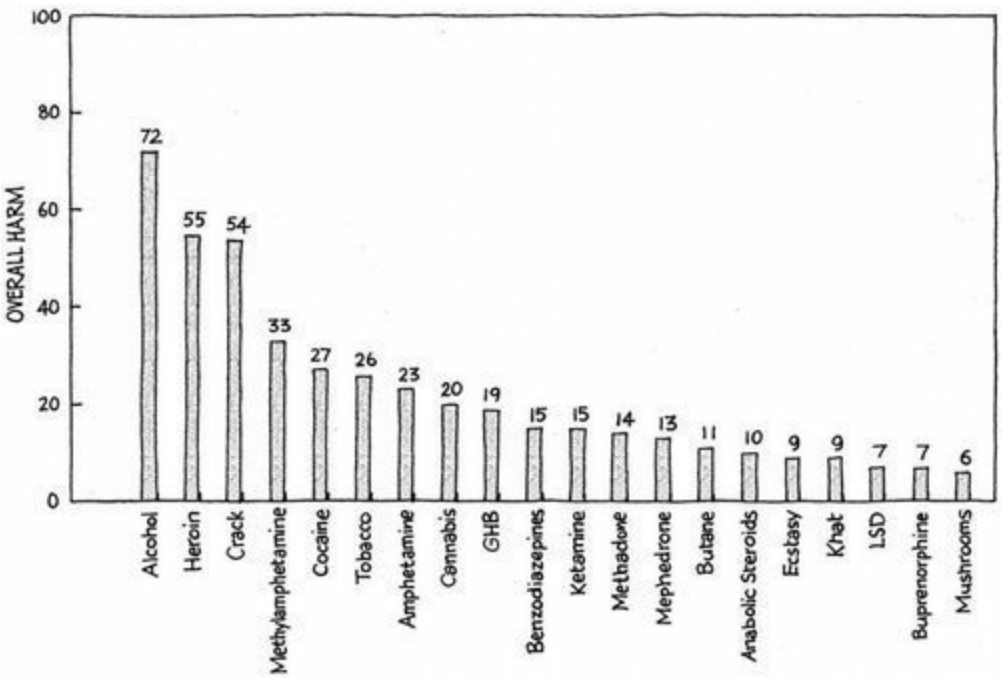

Figure 13. Drug Harm, Weighted Score[132]

One recent study indicates that cannabis use could actually protect against the impact that alcohol has on the liver.[133] With a sample size of 319,514 patients who had past or current histories of alcohol abuse, Adeyinka Adejumo et al. divided up the patients into three groups: non-cannabis users (90.4 percent), non-dependent cannabis users (8.26 percent), and dependent cannabis users (1.4 percent). Results indicate that significantly fewer instances of numerous diseases, to include cirrhosis, hepatocellular carcinoma, and liver disease are found in dependent and non-dependent cannabis users.[134]

Other research reinforces Nutt's main argument—that cannabis use is relatively harmless. In a landmark review of epidemiological analyses, Rebecca Crean et al. assert

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[132] Source: Nutt, loc. 1045.

[133] Adeyinka C. Adejumo et al., "Cannabis Use Is Associated with Reduced Prevalence of Progressive Stages of Alcoholic Liver Disease," *Liver International* 38 (2018): 1475–86, https://doi.org/10.1111/liv.13696.

[134] Adejumo et al.

that cognitive impairment due to long-term cannabis use is actually much less significant than what some reporting indicates. Generally speaking, negative long-term cognitive impacts are only seen in decision-making and risk-taking.[135] See Table 6 for details.

Table 6. The Effects of Cannabis on Executive Functions[136]

Executive Function Measured	Acute Effects	Residual Effects	Long-Term Effects
Attention/Concentration	Impaired (light users) Normal (heavy users)	Mixed findings	Largely normal
Decision Making & Risk Taking	Mixed findings	Impaired	Impaired
Inhibition/Impulsivity	Impaired	Mixed findings	Mixed findings
Working Memory	Impaired	Normal	Normal
Verbal Fluency	Normal	Mixed findings	Mixed findings

Note: Acute Effects denotes 0–6 hours after last cannabis use; Residual Effects denotes 7 hours to 20 days after last cannabis use; Long-Term Effects denotes 3 weeks or longer after last cannabis use.

Other factors could be at play in terms of risk-taking. In effect, which came first—the personality trait or the long-term impact of marijuana? One study indicates that adolescent dating violence could trigger risky behaviors, such as cigarette smoking and suicide attempts. Diann Ackard, Marla Eisenberg, and Dianne Neumark-Sztainer examined data on over 1,500 adolescents; those who reported experiencing physical or sexual violence while dating were more likely to have an increase in tobacco use, suicide attempts, binge-eating, suicidal ideation, depression, and marijuana use in later years. These risky behaviors and the overall risk-taking attribute may very well have been exacerbated by

[135] Rebecca D. Crean, Natania A. Crane, and Barbara J. Mason, "An Evidence Based Review of Acute and Long-Term Effects of Cannabis Use on Executive Cognitive Functions," *Journal of Addictive Medicine* 5, no. 1 (March 1, 2011): 8, http://doi.org/10.1097/ADM.0b013e31820c23fa.

[136] Source: Crean, Crane, and Mason.

marijuana use, not initiated by it.[137] Therefore, there are many factors that go into a young adult's intellectual and cognitive makeup, to include past traumatic events.

Even as early as the 1970s, researchers were studying the long-term cognitive abilities of marijuana users. Albert Carlin and Eric Trupin concluded, after studying ten adult marijuana users over a five-year period, that there are no long-term cerebral impairments in habitual cannabis users.[138]

C. MARIJUANA USE AND MENTAL HEALTH

Long-term cognitive impairment caused by youth-onset marijuana use is backed up by scientific research. In addition, there are other psychological impacts that are being felt throughout the world. Youth-onset cannabis use, for example, increases the "risk of developing a psychotic illness later in life."[139] In another study, Katarina Guttmannova et al. examined 808 Washington state citizens from adolescence into young adulthood. Six mental health markers were counted based upon symptoms presented; the results indicate a heightened risk of generalized anxiety disorder, alcohol and cannabis use disorders, and tobacco addiction for those who reported regular marijuana use. In effect, four out of six mental health markers were present for routine cannabis users as they matured into their twenties and thirties. The study also found that there is no discernible difference in mental health impacts between youth-onset and adult-onset cannabis users.[140]

From an overall wellbeing perspective, one researcher asked the question, "If marijuana is supposed to make us happier, why are we still killing ourselves at such high

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[137] Diann M. Ackard, Marla E. Eisenberg, and Dianne Neumark-Sztainer, "Long-Term Impact of Adolescent Dating Violence on the Behavioral and Psychological Health of Male and Female Youth," *Journal of Pediatrics* 151, no. 5 (November 2007): 476–81, http://doi.org/10.1016/j.jpeds.2007.04.034.

[138] Albert S. Carlin and Eric W. Trupin, "The Effect of Long-Term Chronic Marijuana Use on Neuropsychological Functioning," *The International Journal of the Addictions*, 12, no. 5 (1977): 617.

[139] Matthew Tierney, "Marijuana and Mental Health: Risks and What Nurses Need to Know," *Journal of the American Psychiatric Nurses Association* 22, no. 4 (July–August 2016): 333, http://doi.org/10.1177/1078390316652855.

[140] Katarina Guttmannova, Rick Kosterman, Helene R. White, Jennifer A. Bailey, Jungeun Olivia Lee, Marina Epstein, Tiffany M. Jones, and J. David Hawkins, "The Association between Regular Marijuana Use and Adult Mental Health Outcomes," *Drug and Alcohol Dependence,* 179 (2017): 114, https://nps-illiad-oclc-org.libproxy.nps.edu/illiad/illiad.dll?Action=10&Form=75&Value=206996.

rates?"[141] Hilario Blasco-Fontecilla highlights two growing epidemics in the United States that have reached Spain (and Europe overall) recently: a growing addiction to prescription opioids and, in response to this first epidemic, an increase in illicit opioid use. Following the transition from a licit opioid to an illicit substance, addiction and overdose rates increase. Blasco-Fontecilla posits that the reason for the two growing epidemics on both sides of the Atlantic is the "existential void that which is characteristic of postmodern societies … and the inability of many of its inhabitants to endure it."[142]

This existential void experienced by Westerners, along with opioid addiction, is occurring concurrently with another public health–related phenomena: suicide. Blasco-Fontecilla calls suicidal behaviors, to include ideation, intent, and completed suicide, a "public health problem of the highest order" that generates significant economic expense in Western societies.[143] More importantly, the human toll is enormous: the World Health Organization reports that, worldwide, 793,000 people committed suicide in 2016.[144] With an estimated ratio of 20:1 between attempts and successes, there were approximately 15.9 million attempts worldwide.[145] Blasco-Fontecilla points out that suicide is the second most prominent cause of death for the adolescent age group and that "substance use is a risk factor for suicidal behavior."[146] She also posits that there is a noticeable lack of research on the role that the endocannabinoid system has in suicidal behavior.

Citing a study in which over 13,000 twins were examined, with some twins using cannabis and others not, Blasco-Fontecilla points out that stoned twins attempt suicide seven times more than their non-marijuana-using twin, and are 100 times more likely to

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[141] Hilario Blasco-Fontecilla, "Posmodernidad, sociedades adictivas, cannabis y comportamiento suicida: Hacia un mundo feliz [Postmodernity, Addictive Societies, Cannabis and Suicidal Behavior: Towards a Happy World]?," *Adicciones* 30, no. 1 (2018): 2–3.

[142] Blasco-Fontecilla, 2–3.

[143] Blasco-Fonticella.

[144] "Global Health Observatory Data: Suicide Rates (per 100,000 Population)," World Health Organization, accessed November 2, 2018, https://www.who.int/gho/mental_health/suicide_rates/en/.

[145] World Health Organization, *Preventing Suicide: A Global Imperative* (Geneva, Switzerland: World Health Organization, 2014), http://apps.who.int/iris/bitstream/handle/10665/131056/9789241564779_eng.pdf;jsessionid=E7E2FCFF98B10E7AF25DA02F94C3B0A9?sequence=1.

[146] Blasco-Fontecilla, "Cannabis and Suicidal Behavior," 3.

suffer from suicidal ideation. She concludes her study by stating that there are more than a hundred cannabinoids in marijuana and acknowledges that some have a therapeutic benefit. However, she points out that other cannabinoids, including Δ-9 THC, increase rates of psychiatric morbidity. The report by Blasco-Fontecilla concludes by stating that suicidal behavior has been associated with the use of cannabinoids, and therefore marijuana could actually increase the risk of suicidal behavior.[147]

D. CONCLUSION

Overall, from a medical perspective, the negative effects of long-term marijuana use on the citizens of Colorado are negligible. Risk-taking and decision-making may be linked to use, but overall cannabis is a less destructive drug when overall than tobacco or alcohol. Even if measurable cognitive impairment is evident in youth-onset marijuana users, marijuana does not kill the users in later life. On the other hand, with some evidence pointing to a correlation between cannabis use and suicidal tendencies, continued, long-term analysis would be prudent as states mature in this new era of legalized marijuana.

[147] Blasco-Fontecilla, 4.

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V. STAKEHOLDERS AND THEIR IMPACT

A. PRO-LEGALIZATION GROUPS

Current stakeholders in marijuana legalization include private industry, associated lobbying groups, and lawmakers. With the rise of recreational marijuana in Colorado came a steady increase in revenues for legal-marijuana growers and distributors, with 2014 revenues estimated at $683 million and 2017 at $1.51 billion.[148] As demand increases, these private corporations use their economic power to shape the environment in their interest. The National Cannabis Industry Association recently announced an expanded federal lobbying effort, with the retention of Steve Fox, whose career has spanned almost two decades focusing exclusively on the marijuana industry. In 2005, Fox helped change Coloradans' perceptions by promoting the relatively lower health risks of marijuana as compared to alcohol. This and other lobbying efforts aided in the successful passing of Amendment 64 in Colorado, which legalized retail marijuana.[149] Fox began his marijuana activism career in 2002 when he became director of federal policies for the Marijuana Policy Project. During this time, Fox lobbied successfully with U.S. Representatives Maurice Hinchey (D-NY) and Dana Rohrabacher (R-CA) to bring to the floor of the House of Representatives a first-of-its-kind pro-legalization bill.[150]

Although Fox is just one example of industry prowess in lobbying efforts, he represents a new breed of activists with years of experience in shaping the overall environment in which the marijuana industry has to operate to succeed. This environment includes both the public and political spheres. Through social media, advertising dollars,

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148 "Marijuana Sales Reports," Colorado Department of Revenue, accessed February 15, 2019, https://www.colorado.gov/pacific/revenue/colorado-marijuana-sales-reports.

149 Matt Ferner, "Amendment 64 Passes: Colorado Legalizes Marijuana for Recreational Use," *Huffington Post*, November 20, 2012, https://www.huffingtonpost.com/2012/11/06/amendment-64-passes-in-co_n_2079899.html.

150 "Steve Fox, Leading Advocate for the Legalization and Regulation of Cannabis, Assumes Expanded Role in Cannabis Industry's Federal Lobbying Efforts," National Cannabis Industry Organization, April 26, 2018, https://thecannabisindustry.org/pr/steve-fox-leading-advocate-legalization-regulation-cannabis-assumes-expanded-role-cannabis-industrys-federal-lobbying-efforts/.

and lobbying efforts, the marijuana industry and its lobbying power continue to shape overall public attitude.

Trevor Hughes states that, with cannabis, it is not just lobbying groups, such as the Marijuana Policy Project and the National Organization for the Reform of Marijuana Laws, that are talking to lawmakers: now marijuana business owners are contributing.[151] California Congressman Dana Rohrabacher, who wrote legislation prohibiting the Justice Department from investigating medical marijuana businesses, noticed more marijuana lobbying and marijuana money on Capitol Hill.[152] Congressman Rohrabacher asserts that marijuana lobbyists face a steep learning curve, but they are maturing.[153] It is not just industry and traditional pro-legalization groups that are getting involved in lobbying efforts. The two-million-member American Legion launched a recent campaign to reduce marijuana restrictions for veterans in light of an ongoing suicide epidemic.[154]

During the last week of May 2018, Sabrina Siddiqui of the *Guardian* reported that more than 200 marijuana industry leaders arrived in Washington, DC, with a goal of encouraging the U.S. Congress to embrace legalization.[155] This gathering was not the first of its kind. What was unprecedented, however, was how both sides of the political aisle met with—and pledged support to—the lobbyists. From Mitch McConnell to Charles Schumer, both Republicans and Democrats courted the industry group. And, in a move that stunned many Washington insiders, former Speaker of the House John Boehner became a member of the board of Acreage Holdings, a cultivating and dispensing firm operating in eleven U.S. states. The move was a flip-flop for the Ohio Republican, who once said he

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151 Trevor Hughes, "Marijuana Money Flows to GOP Lawmakers; Lobbying Effort Aims to Stem Federal Crackdown," *USA Today*, January 23, 2018, https://www.usatoday.com/story/news/2018/01/21/marijuana-money-increasingly-flowing-republican-lawmakers/1042239001/.

152 Hughes.

153 Hughes.

154 Evan Halper and Lauren Rosenblatt, "As Trump Wages War on Legal Marijuana, Military Veterans Side with Pot," *Los Angeles Times*, July 21, 2017, http://www.latimes.com/politics/la-na-pol-pot-veterans-201707-story.html.

155 Sabrina Siddiqui, "Joint Effort: Cannabis Lobby Heads to Washington to Woo U.S. Lawmakers," *Guardian*, May 24, 2018, https://www.theguardian.com/society/2018/may/24/cannabis-industry-lobby-washington-legalization?CMP=Share_iOSApp_Other.

was "unalterably opposed" to marijuana decriminalization.[156] All of this lobbying effort translates into marketing campaigns, such as what has emerged in California: advertising targeting retirees, soccer moms, and "folks looking to replace their nightly glass of chardonnay with a precisely dosed, low-calorie, and hangover-free mint. Many have consciously played up cannabis as a lifestyle product, a gift to give yourself, like a nice crystal or an antioxidant face cream."[157] This emphasis on a healthy alternative to other stress relievers is of concern to public health professionals.[158] The increase in cannabis industry money on Capitol Hill as well as the increasingly positive lifestyle advertisement campaigns will result in more Americans using the product in the future.

B. THE IMPACT OF PRO-LEGALIZATION EFFORTS

The net result of this push by industry and dedicated lobbying officials is a record level of support for the legalization of marijuana—see Figure 14. Note that other factors may be at play here, to include increased exposure due to an increasing number of legalized retail states. Although polling data is only available at the national level on public perceptions of marijuana legalization, it is indicative of Colorado as well, in light of Amendment 64 being passed by a majority of Coloradans.

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156 Siddiqui.

157 Annie Lowrey, "America's Invisible Pot Addicts," *The Atlantic*, August 20, 2018, https://www.theatlantic.com/health/archive/2018/08/americas-invisible-pot-addicts/567886/.

158 Lowrey.

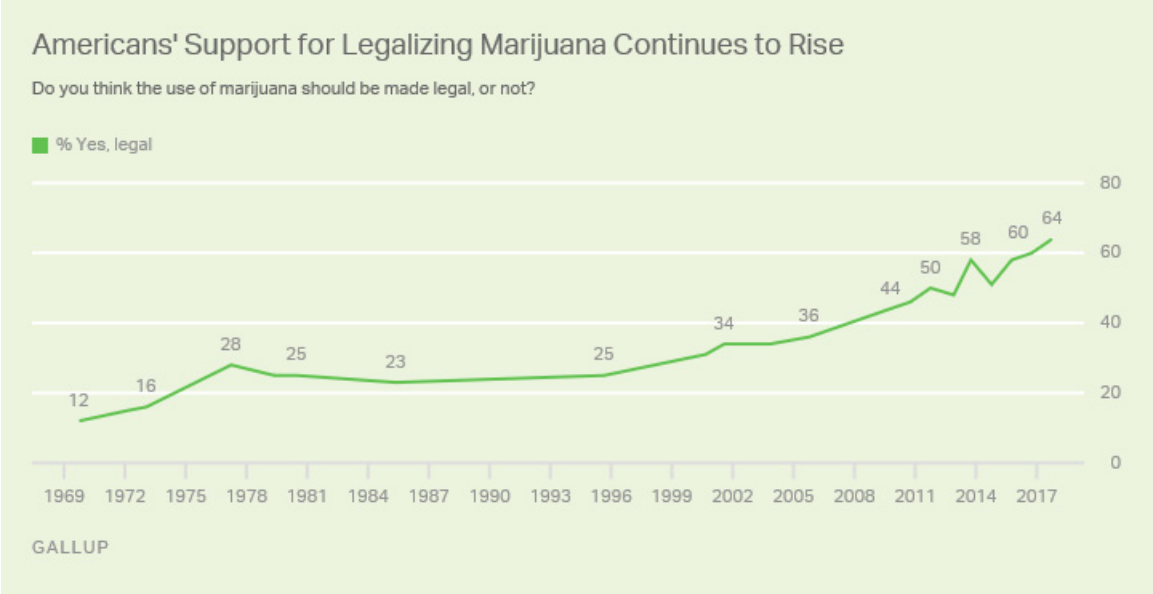

Figure 14. National Support for Legalizing Marijuana[159]

This high level of support for marijuana is not just rising in adults; adolescents are also viewing marijuana more and more as a safe drug. Elizabeth D'Amico postulates that growing positive perceptions of marijuana by American adolescents are due, at least in part, to advertisements.[160] Her recent study indicates that only 25 percent of the thousands of adolescents she was studying in 2010 stated they saw, in the past three months, a pro-medical marijuana advertisement; by 2017, that figure rose to 70 percent. In addition, the more adolescents saw marijuana ads, the more they used. D'Amico concludes by stating:

> When I talk to teens, they'll say "Oh, I would never drink and drive, I know that's really dangerous. But I could use marijuana and drive because it helps me focus, and it's safe." So I think the way it's been marketed—it's medicinal, it's safe, it's natural—gives them a different perspective. Ads

159 Source: Justin McCarthy, "Two in Three Americans Now Support Legalizing Marijuana," Gallup, October 22, 2018, https://news.gallup.com/poll/243908/two-three-americans-support-legalizing-marijuana.aspx.

160 Elizabeth D'Amico, "Signs of the Times: What We Know about Marijuana Ads, So Far," *RAND Review*, September/October 2018, 4, https://www.rand.org/pubs/corporate_pubs/CP22-2018-09.html?utm_source=WhatCountsEmail&utm_medium=RAND%20Review+AEM:%20%20Email%20Address%20NOT%20LIKE%20DOTMIL&utm_campaign=AEM:897182727.

> say: "Goodbye stress, hello marijuana." That's advertising that you don't really see for alcohol.[161]

Advertisements have had a marked input on youth and their decision-making calculus on whether or not to use marijuana; as advertisements increase in both frequency and attractiveness ("it is healthy to imbibe," for example), more and more teens are using marijuana—in fact, Colorado ranks the highest out of all states in the percentage of twelve-to-seventeen-year-olds who reported cannabis use in the October of 2017.[162]

C. ANTI-LEGALIZATION GROUPS

On the opposing side of the argument sit groups such as Smart Approaches to Marijuana (SAM) and the affiliated Marijuana Accountability Coalition. These groups focus their lobbying efforts on packaging counter-arguments against the marijuana industry as well as pro-lobbying groups.[163] Both groups have been attacked for willfully skewing data to fit their arguments against legalization. Westword.com, for example, in response to a tweet by SAM that stated, "New study found that nearly 73 percent of some 4,000 drivers charged with a DUI in Colorado in 2016 tested positive for marijuana. Absolutely insane," responded by arguing that the lobbying group fixated on the overall percentage without stating that only a small amount—five percent, to be exact—tested positive for Δ-9 THC.[164]

Although it is difficult to determine the relative power that each side wields, Figure 14 (presented on the previous page) shows the growing support for marijuana legalization. With this trend increasing dramatically nationwide since the early 2000s, it appears that the pro-legalization groups have the upper hand.

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[161] D'Amico.

[162] Rocky Mountain High Intensity Drug Trafficking Area, "The Legalization of Marijuana in Colorado: The Impact," Volume 5 (report, Rocky Mountain High Intensity Drug Trafficking Area, October 2017), 38, https://rmhidta.org/files/D2DF/2017%20Legalization%20of%20Marijuana%20in%20Colorado%20The%20Impact2.pdf.

[163] See http://marijuanaaccountability.co/campaigns/; https://learnaboutsam.org/.

[164] Michael Roberts, "Anti-pot Groups Twisted Facts to Exaggerate Stoned Driving Problem," Westword, August 17, 2018, https://www.westword.com/news/how-anti-pot-groups-twisted-facts-to-exaggerate-colorado-stoned-driving-problem-10661711.

D. TRAFFIC SAFETY IN COLORADO

In May 2016, four teenagers had just finished up a school year at St. John's Military Academy in Kansas. After spending the night at one of the teen's father's houses, they reportedly were going camping up in the Colorado Rockies. On a curvy road near Conifer, one report indicated the car ran straight off a turn in the road, down a hill, and then flipped several times before coming to rest in a creek.[165] Only one of the teens survived the crash. Officers found Xanax and 8.5 ng/mL of Δ-9 THC in the driver's blood.[166] Currently, Colorado's legal limit for marijuana intoxication is 5 ng/mL of THC.[167] What is the science behind the measurement of impairment, and why did 5 ng/mL of THC become the limit? And, more importantly, was the driver actually impaired by marijuana or was it simply a tragic accident?

The legalization of retail marijuana in Colorado has forced state and local agencies to adapt quickly to public safety challenges. These challenges include impaired driving, the operation of heavy machinery, and even childcare issues. Historic methods of measuring marijuana impairment are being questioned by recent scientific research, and inconsistent reporting of marijuana intoxication during post-crash investigations makes it difficult to determine the actual extent of marijuana-impaired driving in Colorado.

This section highlights the science of marijuana intoxication and the technology behind measuring driver impairment due to marijuana. It begins with a discussion of the differences between alcohol and THC levels related to impairment, followed by a close examination of current detection methods related to general drug impairment used by Colorado law enforcement agencies. The section then concludes with an examination of overall road safety data as well as traffic fatality rates in the era of legalized marijuana.

The effects of alcohol-impaired driving, and consequently the science behind it, are well understood. In general, two standard drinks, roughly half an ounce of alcohol in an

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165 Migoya, "Traffic Fatalities."

166 Migoya.

167 Migoya, "Are you High?"

hour, equates to a rise in blood alcohol level of 0.05 percent.[168] THC levels in the bloodstream are measured to ascertain marijuana impairment. A controlled experiment conducted by Julian Azorlosa, Mark Greenwald, and Maxine Stitzer indicates that THC levels can vary between 70 and 140 ng/mL of THC immediately following the smoking of one marijuana cigarette.[169] THC levels for vapor ingestion, or edibles, are typically higher, but also tend to have a huge disparity in the actual rate of distribution into the bloodstream.[170] However, according to NHTSA, these levels are found immediately after smoking but rapidly dissipate.[171] It is this quick dissipation that has many skeptics concerned about mandating maximum levels of THC in the bloodstream in a post-crash environment.

Currently, Colorado law enforcement agencies use a twelve-step Drug Influence Evaluation Facesheet, or a Standard Field Sobriety Test (SFST), which involves both on-scene examinations of interviews and response times as well as laboratory toxicological examinations.[172] Vitals are taken and drivers are asked to perform physical tasks such as walking in a straight line, raising one leg at a time, and touching their finger to their nose (see Figures 15 and 16). Both of these evaluations are subsequently used to determine overall impairment levels.

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[168] Migoya.

[169] Julian L. Azorlosa, Mark K. Greenwald, and Maxine L. Stitzer, "Marijuana Smoking: Effects of Varying Puff Volume and Breathhold Duration," *The Journal of Pharmacology and Experimental Therapeutics* 272, no. 4 (October 1994): 564, http://brainimaging.waisman.wisc.edu/~perlman/papers/azorlosa_marijuana_1995.pdf.

[170] Migoya, "Are You High?"

[171] Migoya.

[172] Migoya.

COLORADO DRUG INFLUENCE EVALUATION FACESHEET

Rolling Log # ____-____-____ Case # ____

Type of Evaluation: ☐ Enforcement ☐ Field Certification/Recertification ☐ Other ____

ADMINISTRATIVE DETAILS

DRE Name / DRE Number	DRE Agency	Arrest Date / Arrest Time	Time DRE Notified	Time Evaluation Started

Witness/Scribe	Witness/Scribe is: ☐ DRE Instructor ☐ DRE	County of Arrest

Miranda Warnings Given By	Time of Miranda	Location of Evaluation	Crash: ☐ N/A ☐ Injury ☐ Fatality ☐ Property

SUBJECT INFORMATION AND QUESTIONS

Subject's Name (Last, First, MI)	DOB / Sex ☐ M ☐ F	Race	Driver's License Number and State

What time is it? / Actual Time	What is the date?	What have you eaten today and when?	What have you had to drink today and when?
/			

When did you last sleep? / For how long?	Are you sick or injured?	Diabetic ☐ Yes ☐ No / If Yes, do you take Insulin? ☐ Yes ☐ No / Epileptic ☐ Yes ☐ No

Do you have any physical impairment?	Are you under the care of a doctor or dentist? ☐ Yes ☐ No If yes, name:	What medications or drugs are you taking?

1. BREATH TEST

Breath Test Results ____ **Instrument Number** ____ **Time** ____ ☐ BAC ☐ PBT

2. INTERVIEW OF ARRESTING OFFICER

Name ____ **Agency** ____ **Agency Case#** ____

3. PRELIMINARY EXAMINATION

First Pulse ____ **(beats per minute) at** ____ **hours.** *(Transfer to section 6)*

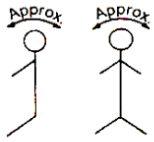
Attitude	Coordination	Speech	Breath	Facial Color

Corrective Lenses	Blindness	Eyes	Eyelids	Pupil Size	Able to follow the stimulus?	Equal Tracking?
☐ Hard Contacts ☐ Soft Contacts ☐ Glasses ☐ Colored	☐ None ☐ Left ☐ Right	☐ Near Normal ☐ Bloodshot ☐ Watery ☐ Reddened Conjunctiva	☐ Normal ☐ Droopy	☐ Equal ☐ Unequal	☐ Yes ☐ No	☐ Yes ☐ No

4. EYE EXAMINATIONS

HGN	Right	Left	Vertical Gaze Nystagmus	Notes and Observations
Lack of Smooth Pursuit	☐ Pres ☐ No	☐ Pres ☐ No	☐ Yes ☐ No	____
Distinct & Sustained Nystagmus at Maximum Deviation	☐ Pres ☐ No	☐ Pres ☐ No	**Lack of Convergence** ☐ Yes ☐ No	
Angle of Onset	____°	____°	Right ( ) Left ( )	

5. DIVIDED ATTENTION TESTS

Romberg Balance	Eyelid Tremors ☐ Yes ☐ No	How many seconds?	Notes and Observations
	____ seconds estimated as 30 seconds.	How did you estimate the time? ____	____

Version 05/2012 Page 1 of 2

Figure 15. Colorado Drug Influence Evaluation Facesheet, Page 1[173]

[173] Source: "The Colorado Drug Influence Evaluation Facesheet," Colorado Department of Transportation, May 2012, https://www.codot.gov/safety/dre/colorado-dre-facesheet.

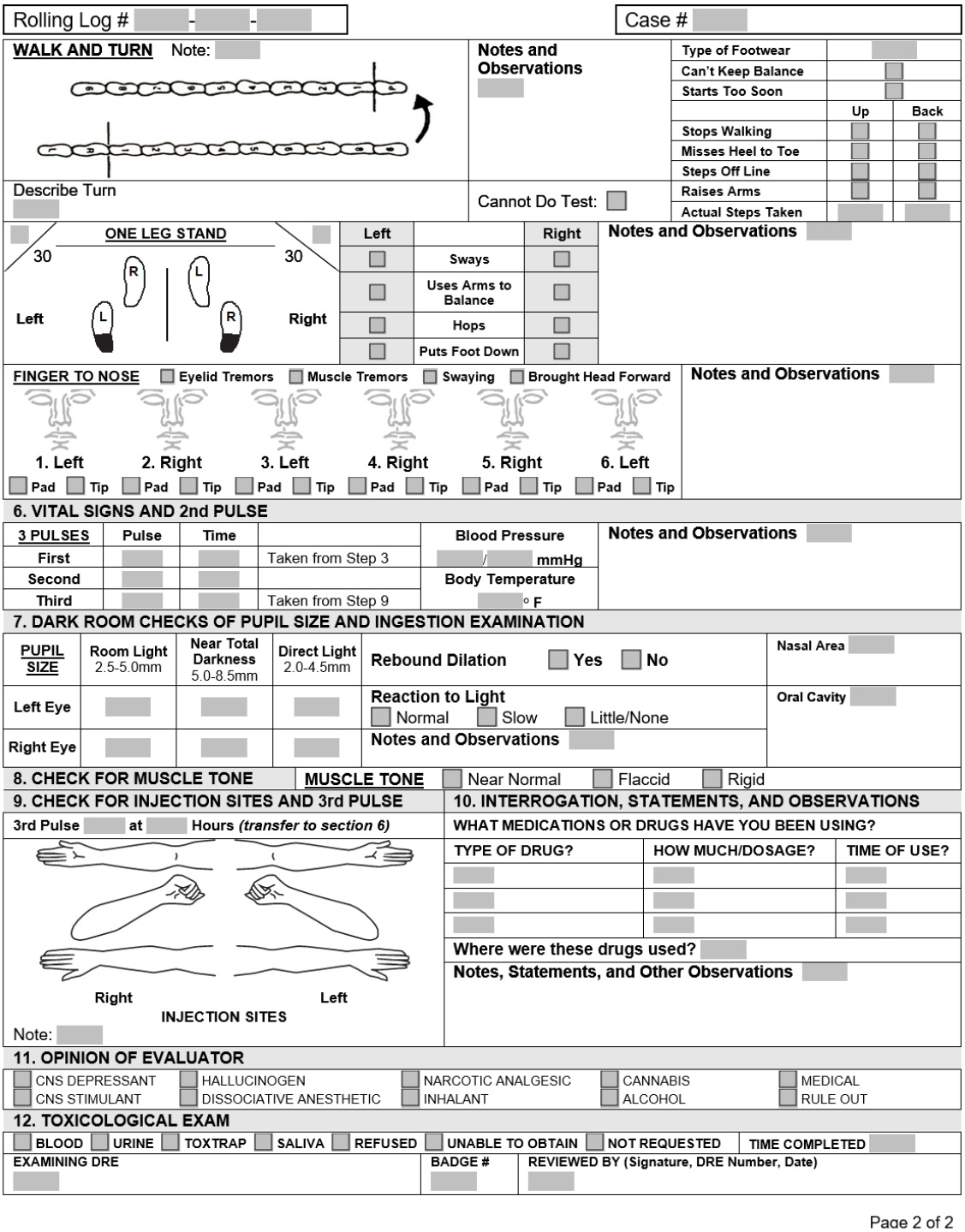


Figure 16. Colorado Drug Influence Evaluation Facesheet, Page 2[174]

[174] Source: Colorado Department of Transportation.

Why does current law enforcement focus seem to be centered on THC levels? Marijuana contains hundreds of compounds, many of which are hallucinogenic.[175] And, as highlighted above, the very issue of whether or not marijuana impairs driving seems to be in question. What does one make of these contradictory studies and findings?

The human body absorbs alcohol much differently than marijuana. In "Assessing Marijuana Intoxication," Dr. Matthew Lee states that ethyl alcohol is the only intoxicant in alcohol and it is linearly excreted by the human body over time immediately following consumption.[176] With only one intoxicant, blood alcohol levels equate to a corresponding degree of impairment in a standard individual.[177]

In comparison, the compound routinely tested for in marijuana (Δ-9 THC) is but one of many chemical compounds (both psychoactive and inactive) that can be found in the human body during and after use. In stark contrast to ethanol, which is water-soluble, Δ-9 THC is almost immediately absorbed by fat cells which then slowly secrete it. This buildup in fat cells does not contribute to intoxication.[178] Δ-9 THC does contribute to intoxication in the brain, but its effects are quickly dissipated; see Figure 17. This rapidly diminishing footprint of Δ-9 THC in the bloodstream as it transitions into the body's fat cells is dependent on many variables, to include the weight of the individual as well as his or her tolerance level.[179]

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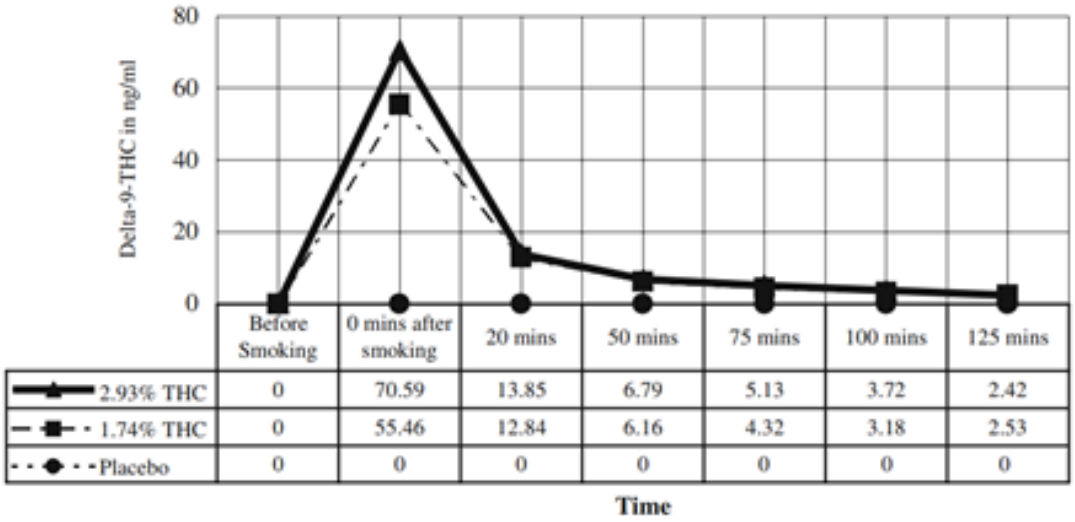
175 Richard P. Compton, *Marijuana-Impaired Driving: A Report to Congress*, DOT HS 812 440 (Washington, DC: National Highway Traffic Safety Association, July 2017), 4, https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812440-marijuana-impaired-driving-report-to-congress.pdf.

176 Matthew C. Lee, "Assessing Marijuana Intoxication," ExpertPages, accessed February 15, 2019, https://expertpages.com/news/Assessing_Marijuana_Intoxication.htm.

177 Lee.

178 Lee.

179 K. Papafotiou, J. D. Carter, and C. Stough, "An Evaluation of the Sensitivity of the Standardised Field Sobriety Tests (SFSTs) to Detect Impairment Due to Marijuana Intoxication," *Psychopharmacology* 180, no. 1 (2005): 107–14, http://dx.doi.org.libproxy.nps.edu/10.1007/s00213-004-2119-9.



	Before Smoking	0 mins after smoking	20 mins	50 mins	75 mins	100 mins	125 mins
2.93% THC	0	70.59	13.85	6.79	5.13	3.72	2.42
1.74% THC	0	55.46	12.84	6.16	4.32	3.18	2.53
Placebo	0	0	0	0	0	0	0

Figure 17. THC Levels over Time[180]

Colorado, with an established legal limit for Δ-9 THC of 5 ng/mL in the bloodstream, can *charge* someone with driving under the influence (DUI) for exceeding this level. This is different than alcohol, where a reading of 0.08 percent is the only measurement needed to *convict* someone of drunk driving.[181] This represents the difference between permissible inference (marijuana) versus per se (alcohol) evidence. In terms of suspected marijuana-impaired drivers, permissible inference requires a Colorado judge or jury to decide whether the driver was impaired or not, after considering the entire body of evidence collected, to include the SFST conducted on-scene.[182] NHTSA, in its 2017 report to Congress on marijuana-impaired driving, states that "this per se limit appears to have been based on something other than scientific evidence"—and yet Colorado continues to use it as one of two evidentiary factors in determining impairment.[183] The NHTSA report examined a Washington state study released in 2013 that analyzed driver THC levels in 6,000 traffic cases involving impaired driving between 2009 and 2013. Of these cases, 3,184 of the drivers had THC levels above 1 mg/mL,

[180] Source: Lee, "Assessing Marijuana Intoxication."

[181] Lee.

[182] Migoya, "Are You High?"

[183] Compton, *Marijuana-Impaired Driving*, 28.

62 percent of whom had THC levels below Colorado's limit of 5 ng/mL, despite the fact that the arresting officer believed the driver was impaired by marijuana.[184] If 60 percent or more drivers are deemed impaired by the on-site law enforcement officer yet they do not have a plasma THC level above Colorado's limit, then some potentially dangerous drivers out on the roads may not be punished for their reckless behavior.

NHTSA also examined another Washington state report which analyzed 602 cases of impaired driving where only THC was detected in the driver (no alcohol or other drugs). NHTSA concluded that "poor correlation between THC concentration and performance was found, which again indicates that blood THC level is not a reliable indicator of impairment."[185] What these issues point to is the mixed result of analysis with respect to marijuana-impaired driving. NHTSA's response is simple: conduct more analysis and ensure that reporting is standardized across all fifty states.[186] But is reporting standardized even within Colorado? The challenges surrounding the current evidentiary process in Colorado to positively identify a driver as marijuana-impaired are numerous—whether or not Δ-9 THC is the best marker of impairment is just one.

Besides inconsistencies in the testing of live human beings, inconsistencies have been noted in the testing of deceased individuals. The *Denver Post* reports that *some* coroners in the state's sixty-four counties do test—and report on a death certificate—the existence of Δ-9 THC in the victim.[187] With this inconsistency, it is difficult to draw conclusions from fatal crash data throughout the state.

Law enforcement agencies are also inconsistent in testing. The Greenwood Village Chief of Police states that "with alcohol if you blow .08 [law enforcement agencies] are done and doesn't care about marijuana … it's $500 for that [marijuana] test, a two-hour wait, staff time, and it makes little difference if there is marijuana."[188] One officer from

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[184] Compton, 28–29.

[185] Compton, 29.

[186] Compton, 31.

[187] Migoya, "Traffic Fatalities."

[188] Migoya.

the Denver Police Department's traffic investigations division reported that they test for alcohol and stop after that if there is a positive result, never testing for marijuana.[189] These inconsistencies and inaccuracies in the testing of impairment and actual use make any findings of "no impact" flawed.

Inconsistency in reporting not only complicates statistics-driven research; it also may obscure a more insidious impact of marijuana-impaired driving: the synergistic effects of alcohol, marijuana, and other drugs, when taken in combination prior to getting behind the wheel. One study, using the National Advanced Driving Simulator at the University of Iowa, indicates that both alcohol and marijuana have a detrimental effect on drivers' ability to stay within their lane, but if mixed together the impact is additive.[190] Among all fatal vehicle crashes in 2016 in Colorado, alcohol was found in 36 percent of the drivers.[191] Trend analysis may be used in the years to come *if* standardized and consistent testing and reporting can determine the levels of driver impairment by both alcohol and marijuana in crashes involving drivers who mixed the two substances.

In the past, other methods measured marijuana use, such as urinalysis testing. One compound found in marijuana—carboxy THC—is released in urine over time and represents the highest percentage of any compound detected in marijuana users.[192] Sarah Urfer, who manages a Boulder lab that handles 75 percent of statewide DUI cases, states that "nobody thought it mattered what you were looking for.… early on, scientists didn't know for sure which of the cannabinoids were responsible for impairment. They'd measure carboxy and try to correlate it to impairment."[193] This hit-and-miss approach to finding the right compound to indicate impairment is troubling from a legal and public safety perspective. Urfer goes on to assert that THC levels found in the blood drop off rapidly after smoking a joint, and the THC is then distributed into muscle and brain tissue. It is the

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[189] Migoya.

[190] Compton, *Marijuana-Impaired Driving*, 11.

[191] Migoya, "Are You High?"

[192] Migoya.

[193] Migoya."

THC transitioning into the brain cells that causes impairment.[194] That translates to a THC blood rate in the precinct showing far lower level than it would have been at the time of the crash.[195] And that rapid decrease in Δ-9 THC as compared to the relatively slow decrease in ethanol over time is what makes current testing procedures imperfect.

Blood tests for Δ-9 THC represent just half of the testing currently performed by law enforcement agencies in Colorado. The twelve-step SFST can potentially be enhanced for more accurate detection of marijuana impairment. One such recommended change is recording head motion and/or jerks, whereby marijuana-impaired drivers are unable to follow a moving stimulus with their eyes without moving their head as well.[196]

Measuring marijuana impairment in Colorado has been elusive. Although standards exist for on-site testing, subject matter experts strongly disagree about whether or not the correct compound is even being measured. There is also inconsistency in reporting among government officials, which can complicate statistic-driven research. Despite the issues with measuring marijuana intoxication, as well as the inconsistencies in reporting, traffic fatality data show a steady increase in overall deaths on Colorado roads (see Figure 18).[197]

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194 Migoya.

195 Migoya.

196 Papafotiou, Carter, and Stough, "Sensitivity of the Standardised Field Sobriety Tests," 108.

197 "General Statistics: State by State," Insurance Institute for Highway Safety Highway Loss Data Institute, accessed January 13, 2019, https://www.iihs.org/iihs/topics/t/general-statistics/fatalityfacts/state-by-state-overview/2017.

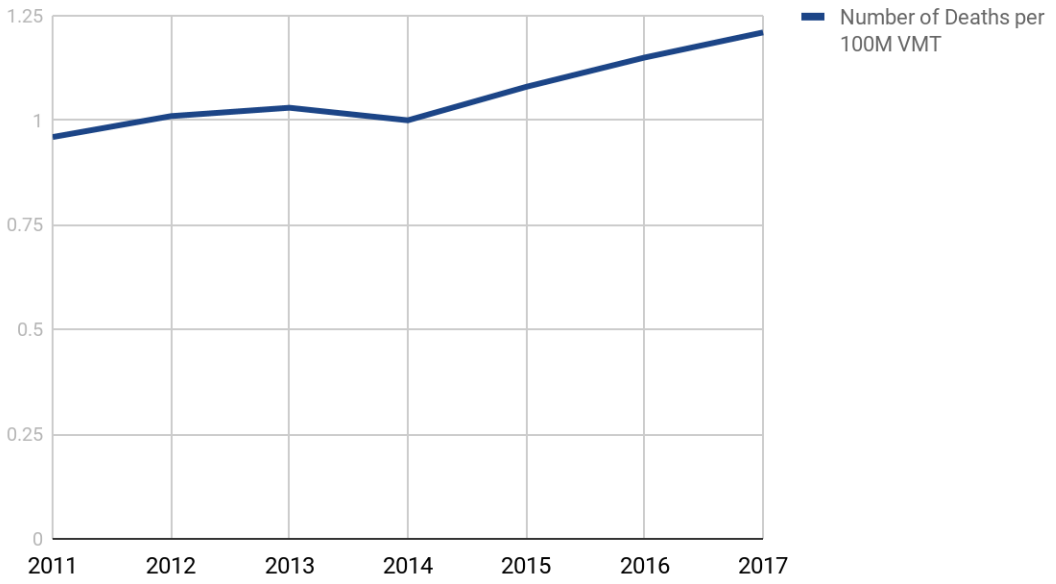

Figure 18. Colorado Traffic Fatalities by Year per 100M Vehicle Miles Travelled, 2011–2017[198]

However, until toxicology reporting is standardized across the state, and there is a more reliable method of field testing for marijuana-induced impairment, attempts to draw correlations between the rise in traffic fatalities and the legalization of marijuana are purely speculative. Enhancements to the current SFST can be made to better detect marijuana impairment. It is recommended that the maximum blood level of 5 ng/mL for Δ-9 THC should be eliminated as a measure of impairment in Colorado. Until a more accurate marker of impairment in the brain is found, an enhanced twelve-point behavioral test should be used.

198 Source: Insurance Institute for Highway Safety.

E. SUICIDE IN A LEGALIZED STATE

Based upon data collected for the Colorado Violent Death Reporting System, suicide death rates for young adults ages twenty to twenty-four have actually tapered off since legalization—see Figure 19.[199]

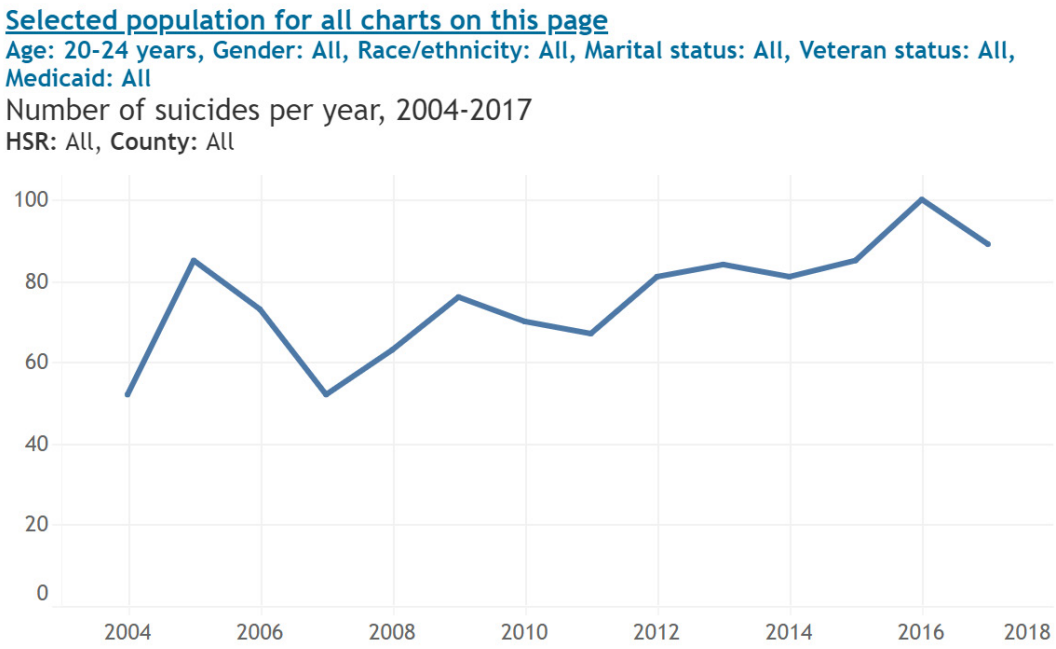

Figure 19. Number of Suicides per Year, 2004–2017, Ages 20–24[200]

The demographic that shows the highest number of marijuana users since legalization is the young adult cohort, while the highest rate of suicide is consistently

199 Source: "Suicides in Colorado: An Overview," Colorado Violent Death Reporting System, accessed January 13, 2019, https://cohealthviz.dphe.state.co.us/t/HSEBPublic/views/CoVDRS_12_1_17/Story1?%3Aembed=y&%3AshowAppBanner=false&%3AshowShareOptions=true&%3Adisplay_count=no&%3AshowVizHome=no#8.

200 Source: Colorado Violent Death Reporting System.

among the forty-five to fifty-four-year cohort.[201] Therefore, the age group that uses marijuana more than any other in Colorado is not showing signs of increased suicides.

How does Colorado compare to other states? The Colorado Health Institute reports that Colorado remains in the overall top ten states with the highest suicide rates. Montana leads the country at 25.9 per 100,000 while Colorado ranks ninth at 20.5 per 100,000. Most of the top ten states are considered "mountain states," with the exception of Nevada, Oklahoma, and Alaska. From a chronological perspective, suicide rates have been on the rise since 2005. Ceri Price et al. conducted a longitudinal study on over 50,000 Swedish military conscripts and found that "although there was a strong association between cannabis use and suicide, this was explained by markers of psychological and behavioural problems."[202] With the majority of the top-ten suicide states in the Midwest or Mountain West region of the United States, other factors might be at play besides the presence—or absence—of legalized retail marijuana.

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201 "Marijuana Use in Colorado: Results from Colorado's Population-Based Surveillance Systems," CDPHE, accessed February 15, 2019, https://www.cohealthdata.dphe.state.co.us/chd/MJ/Marijuana%20Use%20in%20Colorado%20Infographic-2014-and-2015versionFinal%20copy.pdf; Colorado Violent Death Reporting System, "Suicides in Colorado."

202 Price et al., "Cannabis and Suicide," 492.

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VI. THE URUGUAYAN EXPERIENCE WITH MARIJUANA LEGALIZATION

Uruguay legalized marijuana one year after the state of Colorado, but their policies and implementation plans are strikingly different from each other. Regardless, lessons can be learned from our hemispheric neighbor to the south about how to optimally transition to a legal marijuana environment.

Uruguay, with a population of 3.4 million, legalized cannabis in December 2013.[203] To discuss similarities and differences between two democracies, one can examine nations through the lens of substantive versus procedural democracies.[204] For the purposes of this analysis, Colorado is viewed at the nation-state level. Taking into account political effectiveness, accountability, and stability, as well as the absence of violence, corruption, or terrorism and the existence of the rule of law, the World Bank's Worldwide Governance Indicators database examines nation-states on a percentile ranking, from 0 to 100, with 100 being optimal.[205] For the year 2016 (the most recent year of data available), the United States ranks 84.24 while Uruguay ranks 86.70 in terms of voice and accountability. In terms of government effectiveness, the United States comes in at 91.35 while Uruguay ranks 73.08. Finally, in terms of rule of law, Uruguay ranks 73.56 while the United States is at 92.31. These three categories (rule of law, government effectiveness, and voice and accountability) represent key indicators of the existence of a substantive versus a procedural democracy. Both nation-states are similar in scoring.

From a socio-economic perspective, both Uruguay and Colorado maintain a strong and vibrant middle class. Uruguay, for example, has 53 percent of the population

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203 Central Intelligence Agency, *World Factbook* (Washington, DC: CIA, 2018), https://www.cia.gov/library/publications/the-world-factbook/geos/print_uy.html; John Hudak, Geoff Ramsey, and John Walsh, "Uruguay's Cannabis Law: Pioneering a New Paradigm," Brookings Institute, March 21, 2018, https://www.brookings.edu/research/uruguays-cannabis-law-pioneering-a-new-paradigm/.

204 William A. Galston, "On the Reemergence of Political Pluralism," *Daedalus* 135, no. 3 (Summer 2006): 118–122, https://www.jstor.org/stable/20028060.

205 "Worldwide Governance Indicators," World Bank, accessed August 12, 2018, http://info.worldbank.org/governance/wgi/#reports.

considered to be in the middle class.[206] The United States, on the other hand, has roughly 50 percent of the population classified as middle class.[207] Finally, from a crime indicator rate, the United Nations reports that Uruguay had a rate of 7.69 intentional homicides per 100,000, while the United States had a rate of 5.35 per 100,000 in 2016.[208] From a data-richness perspective, both countries are relatively transparent in terms of ease of availability of reporting on a variety of subjects, to include socio-economic, political, and homeland security data.

Uruguay has had a unique approach to drug policy. John Hudak, Geoff Ramsey, and John Walsh state that "even during the 1973–85 dictatorship, the country was out of step with the highly punitive 'drug war' approaches being implemented in other countries."[209] Minimal amounts of illicit substances were decriminalized. Throughout the years following the collapse of the dictatorship and a return to democracy, civil society groups noticed the disparity between the illegality of purchasing cannabis and the legality of marijuana possession, and, in response, began pushing for legalization.[210] In 2012 two political initiatives were merged to form a single resolution to legalize recreational marijuana. The majority party at the time, Broad Front, crafted a bill to legalize home cultivation and the possession of 25 grams of cannabis. At the same time, then-President Jose Mujica proposed "the creation of a state monopoly over cannabis production and distribution."[211] Both initiatives came together to create a bill that legalized home cultivation, recreational sales, and cannabis clubs, and that "allowed users to grow in state-

206 Mats Skjervheim Thorsen, "Growing Culture: An Ethnographic Study of the Legalization of Cannabis in Uruguay" (master's thesis, University of Oslo, 2016), 19, http://urn.nb.no/URN:NBN:no-55082.

207 "The American Middle Class Is Losing Ground: No Longer the Majority and Falling Behind Financially," Pew Research Center, December 9, 2015, http://www.pewsocialtrends.org/2015/12/09/the-american-middle-class-is-losing-ground/.

208 "Statistics on Crime," United Nations Office on Drugs and Crime, May 19, 2017, http://www.unodc.org/unodc/en/data-and-analysis/crime-and-criminal-justice.html.

209 Hudak, Ramsey, and Walsh, "Uruguay's Cannabis Law," 2.

210 Hudak Ramsey, and Walsh, 2.

211 Hudak, Ramsey, and Walsh, 2.

authorized collectives."[212] The bill was signed into law on December 20, 2013.[213] Within the text of the law itself, the following goals were enumerated:

1. Reducing trafficking violence by taking cannabis off the black market
2. Promoting public health through education and prevention campaigns
3. Eliminating the existing legal paradox that allowed for possession but effectively blocked users from accessing cannabis[214]

Finally, the law created a regulatory agency designed to manage the legalized cannabis market at the national level—the Institute for the Regulation and Control of Cannabis (IRCCA). The IRCCA mandates maximum THC at 15 percent, with a maximum purchase amount per adult limited to 40 grams per month. In addition, the IRCCA is empowered to regulate all aspects of the market, from cultivation to sales.[215]

The legalization of marijuana in Uruguay faced backlash on the international stage. As recently as 2016, the International Narcotics Control Board condemned the move, stating "such legislation is contrary to the provisions of the international drug control conventions."[216] Uruguay has countered that the UN drug control treaties have failed to succeed in their goal of protecting the health and welfare of humankind. Uruguayan government officials argue that legalization is a human rights issue, to include the elimination of illegal narcotrafficking within its borders.[217]

From a consumer perspective, each Uruguayan citizen that chooses to purchase legal marijuana must be eighteen years of age and is registered into the Minister of Health's database. The price of marijuana is fixed at $1 per gram. As Ricardo Baptista-Leite and

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[212] Hudak, Ramsey, and Walsh, 2.

[213] Hudak, Ramsey, and Walsh, 2.

[214] Hudak, Ramsey, and Walsh, 2.

[215] Ricardo Baptista-Leite and Lisa Ploeg, "O Caminho para a Legalização Responsável e Segura do Uso de Cannabis em Portugal [The Road towards the Responsible and Safe Legalization of Cannabis Use in Portugal]," *Acat Med Portugal*, no. 2 (February 2018): 120, https://doi.org/10.20344/amp.10093.

[216] Hudak, Ramsey, and Walsh, "Uruguay's Cannabis Law," 7.

[217] Hudak, Ramsey, and Walsh, 7.

Lisa Ploeg note, although the purpose of the legalization bill was to combat illicit drug trafficking, there are some concerns that the mandatory registry at the Ministry of Health might, in the future, be used for purposes other than simply controlling the customer base (i.e., Uruguayan citizens eighteen or older).[218]

From a distribution perspective, Uruguayan citizens have three options: purchase cannabis at a pharmacy, purchase it at a cannabis club, or cultivate it themselves. In a groundbreaking master's thesis on the growing culture of marijuana in Uruguay, Mats Thorsen posits that "only 3,000 have registered for cultivation, but estimates have assumed that maybe 20,000 people cultivate cannabis illegally."[219] Why such a low registration number? Thorsen believes that the reluctance stems from a mistrust of the national government, as end of the military dictatorship was only thirty years ago. Finally, the fact that cannabis club membership is extremely expensive drives a grey market for marijuana, according to Thorsen, with legal purchases being traded illegally at street corners.[220] However, since legalization Uruguayan federal police have aggressively targeted cannabis clubs that routinely sell to tourists, pulling their licenses if they are found guilty.[221] This represents an important lesson to be learned for Colorado law enforcement entities. Groundbreaking primary school education programs have been tested in Montevideo that teach young students substance-use prevention. Results indicate smaller increases or decreases in alcohol, marijuana, and tobacco use in those schools that underwent training as compared to those that did not.[222] The same type of program could be adopted in Colorado.

From a legalization perspective in the case of Colorado, Jonathan Caulkins states that "the near passage of a ballot initiative in California in 2010" motivated Colorado voters

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218 Baptista-Leite and Ploeg, "Legalization of Cannabis in Portugal," 121.

219 Thorsen, "Growing Culture," 83.

220 Thorsen, 84.

221 Hudak, Ramsey, and Walsh, "Uruguay's Cannabis Law," 12.

222 Flavio F. Marsiglia et al., "Adolescent Substance-Use Prevention and Legalization of Marijuana in Uruguay: A Feasibility Trial of the Keepin' it REAL Prevention Program," *Journal of Substance Use* 23, no. 5 (September 2017): 457, https://doi.org/10.1080/14659891.2017.1358308.

to pass a legalization initiative in 2012.[223] Although there are numerous models for legalized marijuana at the state level, both Colorado and Washington state embraced the "so-called alcohol" model.[224] Simply put, this model relies upon private cultivation, production, and sales with government oversight and regulatory practices. Colorado also adopted a regulated market for out-of-state "marijuana tourists," allowing small amounts of marijuana to be purchased by adults from other states.[225]

Colorado has since been under fire for illegal intra-state trafficking of legally purchased marijuana flowing into states that maintain laws prohibiting marijuana use. Specifically, in December of 2014, the attorneys general of Oklahoma and Nebraska filed a lawsuit against Colorado, claiming that legalization laws in Colorado are undermining "Plaintiff State's own marijuana bans, draining their treasuries, and placing stress on their criminal justice systems."[226] Colorado law mandates that you must be twenty-one or older to purchase marijuana from licensed retail stores, with purchases up to 1 gram per visit. You are not required to enter your name into a state-controlled database, but you must present a driver's license for proof of age.[227]

Table 7 outlines key findings when comparisons are made between Uruguay and Colorado in terms of policy implementation, public health, regulatory controls, demographics, and law enforcement impacts for marijuana sales on the black market.

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223 Jonathan Caulkins, *Considering Marijuana Legalization: Insights for Vermont and Other Jurisdictions* (Santa Monica, CA: RAND, 2015), https://nps.primo.exlibrisgroup.com/discovery/fulldisplay?docid=alma991003335229703791&context=L&vid=01NPS_INST:01NPS&search_scope=MyInst_and_CI&tab=Everything&lang=en.

224 Caulkins, 133.

225 Hudak, Ramsey, and Walsh, "Uruguay's Cannabis Law," 20.

226 Caulkins, *Considering Marijuana Legalization*, 4.

227 "Laws about Marijuana Use," State of Colorado, August 13, 2018, https://www.colorado.gov/pacific/marijuana/laws-about-marijuana-use.

Table 7. A Comparative Analysis of Uruguay and Colorado vis-a-vis Legalization

Factor	Colorado	Uruguay
Substantive vs. Procedural Democracy	Substantive	Substantive
Middle Class	50%	53%
Government Oversight of Marijuana	Low (no government sales, no price controls)	High (government sales only, price controls)
Retail Sales	Retail Outlets, Private Homes	Pharmacies, Private Homes, Cannabis Clubs
Public Health	No Limit	15% THC
Traffic Safety	10.9/100,000 traffic deaths in 2016[228]	12.4/100,000 traffic deaths in 2016[229]
Black Market Sales	Intra-state trafficking increased; some policing of outlets providing sales to known intra-state traffickers	No sales to non-citizens; limited local black market sales at street level; heavy policing of cannabis club sales to tourists

228 "Colorado/Population (2016)," U.S. Census Bureau, accessed August 12, 2018, https://www.census.gov/quickfacts/fact/table/co/PST045217; "Colorado Historical Fatality Trends," Colorado Department of Transportation, accessed 12 August, 2018, https://www.codot.gov/library/traffic/safety-crash-data/fatal-crash-data-city-county/Colorado_Historical_Fatalities_Graphs.pdf.

229 "Uruguay Has Lowest Number of Traffic Fatalities in 7 Years," Agencia EFE, December 27, 2016, https://www.efe.com/efe/english/life/uruguay-has-lowest-number-of-traffic-fatalities-in-7-years/50000263-3135067.

Although Uruguay's experience with legalized marijuana is one-quarter that of Colorado's, more time is needed to assess the efficacy of Montevideo's policies. However, one can initially state that with stronger governmental controls come fewer problems, in the case of marijuana legalization. Governmental limits on THC levels as well as outlaws on out-of-state tourist sales could serve as mitigating effects against two of the criticisms levied at the State of Colorado since legalization: rapidly increasing THC levels and intra-state black market sales of Colorado-purchased marijuana. In addition, a statewide database on purchases may have a positive impact on secondary sales to minors, since amounts of marijuana purchased by each citizen could be tracked.

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VII. FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

A. FINDINGS

The legalization of marijuana in some U.S. states has brought with it a mixed bag of benefits and negative impacts. As discussed in Chapter II, there is a mounting body of evidence that suggests that legalization serves as a mitigating factor in the nationwide upswing in opioid addiction and overdose rates. In addition, the examination of traffic fatalities in Colorado does not show a causal link between the increased use of marijuana and deaths behind the wheel, as examined in Chapter IV. The legalization of marijuana has also shifted law enforcement assets away from marijuana and toward other crime enforcement, and has precipitated a drop in overall crimes associated with cannabis. In addition, in accordance with the Iron Law of Prohibition introduced in Chapter III, youth marijuana use has dropped as the glamour of its illegality has all but dissipated. Marijuana does have a downside: adolescents who use marijuana have definite cognitive development impacts later on in life, and are more likely to use other drugs.

Questions remain about the validity of the current testing system and Δ-9 THC limit of 5 ng/mL, as outlined in Chapter IV. Specifically, the cannabinoid being tested and the overall limit are not grounded in science but appear to be used for their simplicity and ease of testing. In addition, inconsistent reporting by coroners and limited testing by law enforcement entities has likely skewed data on the impact of legalization and road safety.

For many of the factors examined, however, not enough time has elapsed and there is insufficient data to fully draw conclusions based upon the last six years of marijuana legalization in Colorado. However, some initial recommendations can be made based upon the correlations discussed in this thesis. As a potential replacement for licit and illicit opioids, marijuana may serve as a safer alternative.

The maturation of Mexican cartels in light of legalization efforts (and successes) throughout the United States, discussed in Chapter III, has brought challenges to U.S. citizens' health as well as to local, state, and federal law enforcement agencies. Mexican cartels have quickly adapted to legal cannabis by transitioning to illicit opioids, which are

lethal and highly addictive. Their market penetration is clear based on the price drop of heroin at the street level as well as the chemical analysis of undercover purchases. Essentially, Mexican cartels have pushed out other suppliers (Asian gangs, for example) and now produce a more potent, much cheaper, and more available opioid product on the streets of Denver than has ever been recorded. Heroin and fentanyl overdoses continue to plague Colorado and the entire nation, and those rates continue to rise.

B. CONCLUSIONS

When it comes to public health, cannabis has both benefits and downsides. Medical literature supports the claim that marijuana use can mitigate the effects of schizophrenia, epilepsy, and chronic pain, as discussed in Chapter III. In addition, there is no consensus on the overall negative impacts to public health that marijuana may have, but there is strong consensus that long-term use has no residual effects on cognitive or physical abilities, with the exception of possible negative impacts to decision-making and risk-taking.

Other factors examined include opioid overdoses and traffic fatalities. Although Colorado continues to break records on an annual basis for the amount and rate per capita of opioid overdoses, as highlighted in Chapter IV, it does so at a slower rate than many of its counterparts. From an overall traffic fatality perspective, Colorado has been faced with an increase in raw numbers since 2011, two years prior to legalization. Reliable statistics on marijuana-impaired drivers involved in serious accidents do not exist due to the inconsistency in reporting at the local level. If coroners do not conduct toxicology reports on traffic fatalities and law enforcement jurisdictions do not mandate marijuana testing due to the cost and time involved, data analysis will be based only on anecdotal evidence.

In terms of suicides in Colorado, there is no evidence that the legalization of retail marijuana has made a positive or negative impact. Although young adults represent the highest percentage of cannabis users, they do not have the most suicide occurrences by age group.

A close examination of Uruguay in Chapter V shows striking similarities with Colorado; lessons can be learned from Uruguay's transition to legalized cannabis. The country's more tightly regulated market could serve as a model for Denver's approach and

may reduce black market trafficking across state lines as well as the manufacture of products with extremely high levels of THC.

At this point in the history of Colorado's "grand experiment" with marijuana legalization, the overall impact is somewhat positive in terms of public health and safety. Other than long-term intellectual capacity issues surrounding youth-onset use of marijuana and the correlation between marijuana use and other health issues (such as cigarette smoking, alcohol use, and other risky behavior), marijuana's impact on the human body is minimal compared to tobacco, alcohol, and most illicit drugs. Suicide rates continue to rise, although recent studies indicate there is no direct link between cannabis use and suicide. Opioid overdose rates within Colorado continue to rise each year, but the increase is diminished somewhat by legal marijuana. Colorado has less of an increase in opioid addiction and overdose rates than other states in the vicinity.

Traffic fatalities continue to occur each year in record-breaking numbers, but traffic fatality data relating to marijuana impairment and driving are not reliable due to inconsistent field testing and toxicology reporting. Polydrug use as it pertains to driving is of particular concern to law enforcement agencies throughout Colorado, and bears monitoring. More time is needed to observe marijuana's impact on Coloradans.

However, some initial observations can be made based upon the first six years of legalization Marijuana is a safer alternative to opioids when used as a painkiller and a viable medicine to mitigate the symptoms of epilepsy and schizophrenia. And the legalization of marijuana has not gone unnoticed by Mexican cartels. Their response was quick and deadly: more potent heroin and fentanyl on Colorado's streets (and the entire nation's for that matter) and a market saturation that borders on a pure monopoly. As Colorado citizens transition off prescription painkillers following recovery from surgery, for example, the Mexican cartels' market dominance of cheap heroin makes it easier for these patients to continue to use and abuse opioids, but with a deadlier product. Chapter III highlights the effects of the Mexican cartels, which are most noticeable among its U.S. neighbors to the south; in particular, Mexico is bearing the brunt of the United States' insatiable demand for illicit drugs, with a record-breaking number of murders each year.

Marijuana is being marketed as part of a healthy lifestyle, with advertisers encouraging users to embrace a stress-free way of life, as outlined in Chapter V. This marketing campaign has impacted all demographic levels in Colorado, including adolescents. Although medical research is consistent on issues surrounding cannabis, such as its addictive properties or long-term cardiopulmonary effects, the science is murkier on its impact on adolescent cognitive development, as Chapter III points out. Use beginning when one is considered a minor may lead to permanent cognitive impairment, with noticeable drops in IQ and memory capability coupled with an increase in psychological morbidity. These physiological impacts are not permanent for those who begin use as an adult. State- and local-level health programs need to emphasize the downside of beginning cannabis use at a young age.

Traffic safety impacts are difficult to ascertain as so much of the investigation into impaired driving—from established blood levels to toxicology reports—is inconsistently applied and defies scientific research. A close look at Uruguay's policies on legalized marijuana shows that state limits on THC percentages (overall potency) and a database of registered users can prevent emergency department visits, overdoses, and sales both to minors and to those who want to sell on the black market in and out of state.

The positive effects of the repeal of Prohibition have been fully documented; they include a decrease in underage drinking, a decrease in the potency of popular brands (a market switch from liquor to wine and beer), and a decrease in violent crime. Citizens are beginning see this effect on the marijuana market in Colorado as marijuana-related crime decreases, other crimes are investigated and closed, and youth use drops. These data points need to be monitored in the future for potential similarities to our nation's Prohibition experience.

Overall, Colorado's experience with marijuana has been a mixed bag, but it shows promise in the long term regarding overall public safety. However, policies need to be improved for the state to fully benefit and monitor Coloradans' experience with this drug.

C. RECOMMENDATIONS

Based on the analysis, this thesis presents several recommendations. Prior to doing so, however, I would like to employ a future studies tool named *nowcasting*. Nowcasting is defined as a practice that "in no way requires a forecast or prediction of the shape or depth of changes to come. From a nowcasting perspective, it is enough to be able to explain, understand and react more rapidly to present trends."[230] By examining significant events that have occurred in the past (such as demographics or opioid prescription rates) and that will have predictable behavior in the future, one can forecast future trends. The nowcasting technique yields the following observations:

Opioid overdose rates will continue to rise nationally and at the state level as the impact of over-prescription in the past continues to shape licit and illicit use patterns. Marijuana is a viable alternative to opioids (licit and illicit) for pain relief and anti-depression treatments. The state of Colorado should be prepared to a) handle more deaths from opioid overdoses and b) attempt to mitigate these deaths by promoting the notion of drug substitution.

With marijuana legalization, more adults are using than ever before. America's love of the motor vehicle is not going away anytime soon; therefore, a strong public health campaign should be launched, focusing on the dangers of impaired driving as well as the synergistic effects of mixing two or more drugs together, including alcohol and marijuana. The following policy recommendations may counter the negative impacts of marijuana legalization on Colorado citizens.

1. Youth Access

- Increase marketing campaigns aimed at minors that emphasize the detrimental (and permanent) impact of marijuana on youth, countering the "healthy lifestyle" and "stress-free" living associated with marijuana use. Marketing channels might include social media, increased law

230 Nieto-Gomez, "A Director of the Present."

enforcement discussions with both primary and secondary school students, and public television advertisements.

- Adopt Uruguay's central registry (via the Ministry of Health). The CDPHE should document sales to each citizen, increasing the state's ability to detect and deter secondary sales to minors. Use state and local law enforcement to investigate and prosecute adults selling to minors; adopt a zero-tolerance approach by taking away an adult's purchasing rights for one year if he or she is convicted of follow-on sales to minors.

2. Traffic Safety and Intrastate Commerce

- Adopt standardized toxicology reporting at the county/city coroner level to include marijuana testing on all traffic fatalities. Utilize the Colorado Bureau of Investigation (CBI) to conduct regional training events for local government officials.

- Develop an enhanced SFST that includes indicators unique to marijuana impairment. Examine best practices by other states and nation-states to determine physical and cognitive indicators of impairment.

- Implement mandatory testing of drivers suspected of marijuana impairment in the local law enforcement facility where they are taken, utilizing funds obtained through marijuana taxation at the local and state level. CBI staff should conduct the training at the regional level.

- Adapt controls on THC levels in cannabis products to avoid increased emergency department visits and overdoses. Based on Uruguay's experience, 15 percent is recommended. Use marijuana sales tax proceeds to hire, train, and retain qualified investigators to conduct random and targeted analysis of THC levels in products.

- Embrace scientific research methods to determine a cheap and effective test for a target cannabinoid that is present in the system, similar to the

breathalyzer used by law enforcement to measure alcohol impairment. Call upon private industry to determine the most efficient means of measuring impairment.

- Drawing from Uruguay's experience, adopt a "no tourist" policy. This would help eliminate the trafficking of marijuana into states that currently outlaw the drug. This move would improve relations between neighboring states and Colorado and decrease the stress on other states' legal justice systems. However, as more and more U.S. states legalize retail marijuana, the level of intra-state trafficking out of Colorado—and its impact—may decrease in the future.

3. Mexican Cartels and Illicit Opioid Trafficking

- Increase training and funding for federal, state, and local counterdrug efforts that target the I-25 corridor, focusing on illicit opioid distribution and sales. Use marijuana sales tax proceeds to equip state and local authorities with the tools necessary to counteract illegal sales.

- Adopt a state-level marketing campaign aimed against opioid abuse (both licit and illicit), reinforcing the dangers of highly potent, highly addictive substances such as heroin and fentanyl. Adopt an aggressive campaign on social media, television, and public school discussion events to publicize the dangers of opioid abuse.

4. Policy Challenges

Challenges to the proposed policy changes include current marijuana users as well as marijuana lobbying groups. Unlike Uruguayan citizens, who were largely opposed to legalization in 2013, Colorado citizens passed a referendum in favor of legalization.[231] Although public opinion may have changed in the past five years, this striking difference in popular opinion (on the eve of legalization for both political entities) may impact how

[231] Caulkins, *Considering Marijuana Legalization*, 5.

successful any changes in marijuana policies are perceived by the general public. Once users have grown accustom to higher THC percentages, for example, they may lobby to maintain a no-limits policy.

To overcome these obstacles, a concerted campaign must highlight the negative impact of impaired driving, the increase in marijuana overdose emergency room visits, and the effect of intra-state trafficking. Outlets could include television, social media, and classroom visits by law enforcement personnel such as state patrol officers.

D. RESEARCH LIMITATIONS

In terms of drug trafficking, profit estimates for Mexican cartels—one key indicator of a successful business is profits or revenues—are not available. In addition, heroin-specific interdiction and arrest rates at the national or state level are not available; data from the Bureau of Justice Statistics and UNODC are not broken down by type of drug. Therefore, the analysis may not be a good indicator of heroin or illicit opioid interdictions or arrests. However, Mexican cartels market a multitude of drugs, so indicators of overall arrests and interdictions may accurately portray trends in Mexican cartel trafficking.

Traffic safety analysis, in light of marijuana legalization in Colorado, is purely speculative at this point. Toxicology reports at the county morgue and field testing on the highway or at the county sheriff's office are not being conducted consistently. In addition, when tests are performed, the wrong substance, Δ9 THC, is being tested, with a blood limit not backed up by scientific research. Finally, many law enforcement agencies stop at alcohol testing once an illegal BAC level is detected, thereby inhibiting any data on mixed drug use and driver impairment. The synergistic effects (increased high) of mixing alcohol and marijuana are known and can heighten impairment of drivers.

E. RECOMMENDATIONS FOR FUTURE RESEARCH

There are many opportunities for further scientific and medical research on the topic of marijuana legalization and public health. A definitive marker for marijuana impairment needs to be identified by the medical research community. This marker test must be relatively simple to conduct in a field setting and should be relatively cheap.

NHTSA and Colorado state agencies—the Colorado Department of Transportation and CDPHE—should conduct further analysis on the impacts of increased marijuana users behind the wheel and overall traffic safety.

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