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The Impacts of Recreational Marijuana Legalization on Colorado Policy Analysis on Amendment 64

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Sarah Wackerbarth, PhD, Committee Chair

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The Impacts of Recreational Marijuana Legalization on Colorado
Policy Analysis on Amendment 64

CAPSTONE PROJECT PAPER

A paper submitted in partial fulfillment of the
Requirements for the degree of
Master of Public Health in the
University of Kentucky College of Public Health

By
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Frankfort, KY

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Abstract

This report is a policy analysis on the impacts of Colorado's Amendment 64. Marijuana is the most commonly used illicit drug in the U.S, and a Schedule 1 Drug under the federal government. Despite this, twenty-nine states and territories in the U.S. have legalized it for medicinal purposes; (Hanson NCSL, 2017) four of which legalized it for recreational purposes. (Hall & Lynskey, 2016) Medical Marijuana has been legal in Colorado since 2009; however, Amendment 64 was passed in 2012 which legalized the possession, retail sale, and purchase of marijuana to Colorado state residents 21 and over. Commercialization in retail stores began January 1, 2014. (Blumenauer & Polis, 2014)

Recreational marijuana legalization has remained a controversial topic. Proponents argue that it would improve public health, benefit economy, and reduce crime and criminal justice expenditure. Opponents argue that it would harm public health, increase crime, and promote marijuana and other drug use. (Dills, Goffard, & Miron, 2016) Colorado was the first to legalize recreational marijuana use, and this study assesses the impacts of Amendment 64 on marijuana use, risk perception, public health, crime, and economy.

The analysis reveals that Amendment 64 did not significantly impact marijuana use, risk perception, or crime from prior to legalization. Legalization did lead to an increase in health care visits, hospital admissions, poison center calls, and marijuana related traffic fatalities and DUI's. However, Colorado modified policies to alleviate these adverse public health impacts. (Ghosh, et al., 2017) Impacts on the economy included increased jobs and state tax revenue. (Reed, 2016)

Keywords: Impacts of Recreational Marijuana Legalization Colorado, Amendment 64 impacts, Effects of Recreational Marijuana legalization in Colorado

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List of Abbreviations

BEST- Building Excellent Schools Today
BRFSS- Behavioral Risk Factor Surveillance System Survey
CBD- Cannabidiol
CDC- Center for Disease Control
CDE- Colorado Department of Education
CDHS- Colorado Department of Human Services
CDOR- Colorado Department of Revenue
CDPHE- Colorado Department of Public Health and Environment
CDPS- Colorado Department of Public Safety
CHS- Child Health Survey *
CHS- Cyclic Hyperemesis Syndrome *
CIAC- Colorado Information Analysis Center
COCCA- Colorado Organized Crime Control Act
COSWP- Colorado Official State Web Portal
CPS- Colorado State Patrol
CVS- Cyclic Vomiting Syndrome
DOJ- Department of Justice
DUID- Driving Under the Influence of Drugs
FARS- Fatality Analysis Reporting System
HKCS- Healthy Kids Colorado Survey
MPG- Marijuana Policy Group
MPP- Marijuana Policy Project
MVA- Motor Vehicle Accident
NCSL- National Council of State Legislatures
NIDA- National Institute of Drug Abuse
NIH- National Institutes of Health
NSDUH- National Survey on Drug Use and Health
ONDCP- Office of National Drug Control Policy
PRAMS- Pregnancy Risk Assessment Monitoring System Survey
RMHIDTA- Rocky Mountain High Intensity Drug Trafficking Area
RML- Recreational Marijuana Legalization
RMPDC- Rocky Mountain Poison and Drug Center
RMPHAC- Retail Marijuana Public Health Advisory Committee
RPC- Regional Poison Center
SAMHSA- Substance Abuse and Mental Health Services Administration (national survey on drug use and health)
THC- Tetrahydrocannabinol
YRBSS- Youth Risk Behavioral Surveillance Survey

*Two of the same abbreviation letters, different abbreviations

Introduction

The legalization of marijuana in the United States has remained a controversial topic, despite this, twenty-nine states and territories in the U.S have legalized it for medicinal purposes (Hanson NCSL, 2017), four of which have legalized and commercialized it for recreational purposes as well. (Hall & Lynskey, 2016)

Although a number of states have legalized marijuana, it still remains classified as a Schedule 1 Drug by the federal government under the Controlled Substances Act. A Schedule 1 drug is considered high potential for abuse and is not accepted for medicinal use in the U.S. (NIDA, 2017)

Marijuana is the most commonly used illicit drug in the U.S., with approximately 22.2 million past-month users. Marijuana is derived from the hemp plant, Cannabis Sativa, and refers to the stems, flowers, and seeds of this plant. This plant contains a mind-altering chemical called delta-9-tetrahydocannanabinaol (THC) and a mixture of other compounds. Marijuana can be consumed in multiple ways, most commonly through "bongs" (pipes or water pipes), "joints" (hand rolled cigarettes), edibles such as tea or brownies, "blunts" (rolled in an empty cigar), or vaporizers. Marijuana has several short-term effects and long-term effects on the brain. When smoked, the THC passes from the lungs into the bloodstream then carried to the brain and organs. This chemical overstimulates certain parts of the brain that have a large amount of receptors that can lead to a sensation of feeling "high." Other short-term effects of this drug include mood changes, difficulty with thinking, altered senses and time, memory impairment, and impaired body movements. (NIDA, 2017)

Long term effects of marijuana, resulting when users begin as teenagers, include reduced memory, learning, and thinking functions. It has also been found to inhibit the way the brain builds connections between certain areas. Studies have shown that those who started smoking marijuana heavily as a teen suffered an average decline of eight IQ points between the ages of 13 and 38. Studies have not shown a noticeable IQ decline in those who began smoking marijuana as an adult. Marijuana has also been linked to mental illness with long term use such as hallucinations, paranoia, or worsening symptoms in schizophrenic patients. It has also been linked to mental health problems such as anxiety, depression, and suicidal thoughts among teens. (NIDA, 2017) It is associated with addiction and dependence, particularly with long term use. Approximately 1 in 11 marijuana users become dependent. (ONDCP, 2016)

Physical ailments have also been affiliated with marijuana such as breathing problems, as smoke can be an irritant to the throat and lungs. Problems with child development during pregnancy have been reported, as well as increased heart rate which could potentially increase the risk of a heart attack. Marijuana smoke is known to contain carcinogenic combusting products; however, the link between marijuana and cancer has been inconclusive. (NIDA, 2017)

Although marijuana is linked to numerous negative mental and physical concerns, it has been recognized for medicinal purposes as well. THC, in particular forms, has been proven to provide certain medical benefits. Currently, two THC-based drugs are even FDA approved, dronabinol (Marinol) and nabilone (CesaMet.) These drugs come in a pill form and are proven to alleviate nausea symptoms in patients undergoing cancer

treatments, and appetite stimulation in AIDS patients with wasting syndrome. (NIDA, 2017)

Several other medical marijuana drugs are currently undergoing clinical trials. A mouth spray, Nabiximols (Sativex), is currently available in the United Kingdom, Canada, and other European Countries and is used to treat neuropathic pain and spasticity in patients with multiple sclerosis. This medicine combines THC with another chemical found in marijuana called cannabidiol (CBD). CBD is not known to provide the rewarding effects of THC and anecdotal reports have linked it to the treatment of seizure disorders. A liquid form of CBD is currently being tested to treat forms of severe childhood epilepsy. These drugs are made from purified chemicals derived from the plant and are considered more promising than the whole plant itself. Development of drugs from botanicals, such as marijuana, can be challenging due to the unknown amount of active chemicals in each plant, and difficulty in assuring accurate and consistent doses of chemicals in product development. There is also little known of the long-term effects of medicinal marijuana. However, despite this, along with the known hazards of smoking, addiction, and cognitive impairments affiliated with marijuana, there continues to be a growing number of states legalizing its use for medical, and more recently, recreational purposes. (NIDA, 2017)

Although marijuana has made legal advances in the United States, it has remained a contentious topic throughout U.S. history. The hemp plant, itself, dates back to the 17th century where it was used for clothing, ropes, and sailing. Marijuana was introduced to the western culture in 20th century for medicinal purposes, and was mainly used for reducing inflammation and muscle spasms. During the 20th century, marijuana was used

recreationally and concerns arose about the potential harmful effects. Anecdotes of marijuana use linked it to increased violence, crime and social deviance, by 1931 it was outlawed in 29 states. By 1937, a Marijuana Tax Act was passed, restricting it those who paid a certain tax on medical and industrial marijuana. By 1947, marijuana was removed from Pharmacopeia, the official list of medicines, and by 1951 it was listed as a narcotic. It soon became listed as a Schedule 1 Drug by the Controlled Substances Act in 1970, categorizing it in the same class as heroin and LSD. During the 1970's, 16 states decriminalized marijuana, but later in 1980s, federal penalties were raised in regards to possession and distribution of marijuana. However, during this time, the Compassionate Investigational New Drug program was initiated by the federal government which allowed a small number of individuals to receive medical marijuana from the federal government. (Blumenauer & Polis, 2014)

In 1996 Proposition 215 was passed by California voters, which marked the first state to allow the sale and medical use of marijuana for patients with cancer, AIDs, and other diseases. This gradually led to the 29 other states in the U.S. that have adopted medical marijuana programs, each state's law possessing structural differences. The state's medical marijuana programs have created grey areas as they attempt to balance state, local, and federal regulations. (Blumenauer & Polis, 2014)

Medical marijuana has been a proven treatment for many patients, but it has also been suggested that a number of people are likely using medical marijuana laws for other purposes. In 2009 a memo, commonly known as the "Ogden Memo", was sent to federal prosecutors by the Department of Justice (DOJ) encouraging federal prosecutors not to focus resources on prosecuting individuals "'whose actions are in clear and unambiguous

compliance with existing state laws providing for the medical use of marijuana,'" and to concentrate on providers who violate both federal and state law, and those who may be covertly operating criminal activity. Medical Marijuana appears to be widely accepted in the U.S. with approximately 70% of Americans favoring the use of medical marijuana, and only 34% of Americans believe that federal laws should be enacted against those who are in compliance with the state laws. (Blumenauer & Polis, 2014)

Medical marijuana has been legal in Colorado since 2000, however, in 2012 Amendment 64 was passed by 55% of voters which legalized the possession, retail sale, and purchase of marijuana for state residents that were 21 or older. On January 1, 2014, Colorado became the first state to commercialize marijuana for recreational purposes. Retail stores began selling it to adults 21 and over, taxes limited to 15% for wholesale price until 2017. An adult can legally possess up to one ounce of marijuana or grow up to six plants for personal use. (Blumenauer & Polis, 2014)

Marijuana has been a significant strain on health care (ONDCP, 2016), and has also cost the United States billions of dollars with incarceration of citizens. Many people believe that incarceration has damaged lives, and therefore marijuana should therefore be legalized. Some believe that legalizing marijuana in the U.S. could also provide stability in the region and reduce violence and deaths related to drug cartel coming from Mexico. (Blumenauer & Polis, 2014) However, the U.S. government does not believe that legalizing or taxing marijuana would eliminate the black market or disband criminal organizations. Some argue that legalizing and taxing marijuana would produce state and local revenue; however, research shows that economic costs of the drug would far outweigh any benefit from revenue. (ONDCP, 2016)

Since the legalization and commercialization of marijuana for recreational purposes is fairly recent and limited to four states, (Colorado, Alaska, Oregon, Washington State), the overall impact of legalization continues to the researched. (Hall & Lynskey, 2016) Advocates for marijuana legalizations believe that legalization will improve public health and traffic safety, increase revenue, stimulate the economy, and reduce crime and criminal justice expenditure. Critics believe that legalization would harm public health, increase crime, reduce teen academic achievement, negatively impact traffic safety, and promote marijuana and other drug or alcohol use. (Dills, Goffard, & Miron , 2016) Colorado was the first state to legalize the recreational use of marijuana, therefore the following study is a policy analysis of Amendment 64 and the impacts it has had on Colorado since its enactment in 2012. (Blumenauer & Polis, 2014) This study is focused on, but not limited to, overall public health impacts, criminal activity, and financial impacts associated with Amendment 64.

Methods

Since the legalization of recreational and medical marijuana in the given number of states, there have been numerous studies and articles on the potential impacts it has had on certain populations in regards to specific interests or concerns. This study is a policy analysis focused on the impact of legalization of recreational marijuana in Colorado.

This was initiated by searching for peer reviewed sources through databases including PubMed, Google, and Google Scholar. The search criteria included key words Marijuana/Marijuana Legalization/Marijuana Effects/Marijuana Laws/Impact of Recreational Marijuana Legalization/ Impact of Recreational Marijuana Legalization in

Colorado/Statistics Recreational Marijuana Legalization Colorado. The PubMed search yielded approximately 70 journal articles, those that included information regarding the impact of recreational marijuana in Colorado were reviewed and pertinent studies were used in the analysis. Several articles that were used in the analysis used were generated by PubMed and found in the "similar articles" tab. Articles that directly pertained to impacts of recreational marijuana legalization on public health issues, economy, crime, marijuana and/or drug use, and risk perception in Colorado were included in the review. Articles that solely focused on medical marijuana legalization, or were dated 2012 or prior, were excluded entirely in all search engines. Google Scholar was also searched using the same key words and search criteria, and data was filtered by year starting with 2017. The search yielded approximately 640 articles and the data was narrowed down and reviewed using the same inclusion criteria as the PubMed Search. The Google Search yielded millions of news articles and data that were not peer reviewed and most were dated 2012 or prior, which were automatically excluded. Only recent data from legitimate marijuana advocacy groups, state legislative organizations, government data, and public policy research organizations pertinent to the topics previously mentioned were utilized in the analysis. Several sources used in this analysis were identified through the reference sections of other accredited sources.

The initial research included the legal history of marijuana including current state laws, followed by the fundamentals of marijuana and its short-term and long-term effects. The National Council of State Legislatures (Hanson NCSL, 2017) is composed of a committee of Legislatures that claim to be bipartisan to both major political parties, and is recognized for unbiased research that state their main purpose is to provide state

legislatures with support and tools to assist in problem solving and effective decision making on national issues. This website provided up-to-date information on all the current U.S. state marijuana laws which was incorporated into this report. An article in *Addiction* (Hall & Lynskey, 2016) was a report on the plausible effects of recreational marijuana legalization based on current policy literature. This article provided current information on U.S. state marijuana laws, specifically states that were legalized for recreational purposes.

The National Institute of Drug Abuse (NIDA) is funded by the National Institutes of Health (NIH) and provides information on the causes and consequences of drug addiction based on research. This data is accessible to the public through their website, in hopes to provide knowledge and improve individual and public health. The basic marijuana information such as legal status, chemical components, usage statistics, medicinal use, and short and long-term effects of marijuana in this report was obtained from the NIDA publication on marijuana. (NIDA, 2017)

During the Obama Administration, The Office of National Drug Control Policy (ONDCP) provided information on frequently asked marijuana topics on the White House website. The relationship between the ONDCP and the White House was formed as a public health effort to help reduce drug use and its consequences in the U.S. (ONDCP, 2017) Under the current administration, the ONDCP page does not provide any information. The previous ONDCP Marijuana FAQ provided information for this analysis that included marijuana dependence facts, marijuana strain on healthcare, and the governments' stances on aspects of marijuana legalization.

A report on federal marijuana policy by two Congressmen, (Blumenaur & Polis, 2014) provided a substantial amount of information for the introduction of this analysis pertaining to the history of marijuana, and timeline of its legal progression in the U.S.

A number of publications were reviewed, and data pertinent to impacts of recreational marijuana legalization in Colorado in regards to public health, traffic, risk perception, marijuana use, crime, and economic impact was analyzed and compiled in this analysis. The Colorado Department of Public Health and Environment (CDPHE) recently published a report (RMPHAC, 2017) presented by the Retail Marijuana Public Health Advisory Committee (RMPHAC), on Colorado-specific health outcomes and patterns after state recreational marijuana legalization. The RMPHAC is a group of established individuals with marijuana expertise who were appointed by the executive director of the CDPHE. This committee meets regularly to review current scientific literature and data on the health effects of marijuana, and provide an executive summary with policy recommendations to the CDPHE every two years. (RMPHAC, 2017) An extensive amount of information and statistics on public health impacts discussed in this policy analysis were obtained from the CDPHE publication (RMPHAC, 2017). Pertinent data used included, but not limited to, impact on marijuana usage in youth and adults, marijuana use in pregnancy, risk perception, and health care visits.

At the time of recreational marijuana legalization, Colorado developed a public health framework to monitor, respond, and prevent harm to the public. An article in Preventive Medicine (Ghosh, et al., 2017) provided a summary of the lessons learned following the implementation of this framework. This article offered insight into the problems Colorado has faced after legalization of recreational marijuana and how they

responded. Being that this is the first state to experience, learn, and respond to these impacts, this report provided insight to other states also interested in implementing recreational marijuana laws. This article provided valuable evidence on the lessons in health behaviors, outcomes, and policy which contributed to the construction of this analysis.

In 2013, the Senate bill 13-283 was enacted by the Colorado General Assembly, which mandated the Division of Criminal Justice in the Colorado Department of Safety to conduct a study on the impacts of Amendment 64, particularly related to criminal activity. The data in this report was obtained from a number of sources including, but not limited to, the CDPHE, National Survey on Drug Use and Health, administered by the Substance Abuse and Mental Health Services Administration, The Colorado Department of Education, The Denver Police Department, Colorado Organized Crime Control Act (COCCA), and the Colorado Information Analysis Center (CIAC). This report was prepared by a statistical analysis, (Reed, 2016), and the data in this publication was heavily referenced in the traffic and crime portion of this analysis.

The Cato Institute published Policy Analysis No. 799 in 2016 (Dills, Goffard, & Miron, 2016)which assessed the effect of state marijuana legalizations. This study included the four states, Colorado, Washington, Oregon, and Alaska, that legalized marijuana recreationally. This study discussed history of marijuana and legislation, as well as the opposing views between advocates and critics of state-marijuana legislation. The assessment included impacts on drug use, youth risk behavior, marijuana prices, tax revenue, health and suicides, marijuana treatment admissions, economy, and crime, further classified by each of the four states. A significant amount of the impacts

mentioned in this study were derived from the National Survey on Drug Use and Health, Substance Abuse and Mental Health Services Administration (SAMHSA). Given the analysis discussed all four states, some of which recently implemented this framework, the scarcity of recent data for certain state topics was considered a limitation to the study. (Dills et al., 2016)

The Rocky Mountain High Intensity Drug Trafficking Area (RMHIDTA) is a sector of the Office of National Drug Control Policy (ONDCP) that works with the federal, local, and state drug enforcements to combat drug trafficking locally, regionally, and nationally. Their mission is implemented through joint multi-agency collocated drug task forces who share information and work with other drug enforcement initiatives. The states that are included in the RMHIDTA cover 286,823 square miles around the Rocky Mountains. In 2013, the RHMIDTA partnered with the Colorado Department of Transportation to help improve toxicology data (Reed, 2016). In September 2016, they put out a fourth edition of their own study on the impact of recreational marijuana in Colorado. This report included the history and background of marijuana legalization, and the impacts on impaired driving, crime, marijuana use, marijuana related exposures, treatments, and health care visits. This report identified relevant impacts and results included in this analysis. Data from their report was also mentioned in several of the articles referenced in this analysis. (Wong, Clarke, & Harlow, 2016)

The impact of recreational marijuana legalization the youth was a particular area of interest throughout the research of this subject. There are several publications dedicated to impacts on youth that included risk perception, unintentional exposures to marijuana, and emergency department or health care visits. An article in JAMA

Pediatrics (Wang, et al., 2016) was a study that evaluated the amount of pediatric marijuana exposures found at a Colorado Children's Hospital and Regional Poison Center (RPC), and compared the results to before and after marijuana legalization. The results were also compared to the national statistics, and their overall evaluation was incorporated into this analysis. One of the authors of this article (Wang, et al., 2016), presented another article in 2016 as the sole contributor (Wang, 2016), which also contributed findings to this analysis. This study was also on the pediatric population, and discussed the effects that cannabis can have from prenatal exposure to unintentional childhood exposures. The study also discussed the short-term and long-term effects of marijuana exposure on the youth. (Wang, 2016) A publication called "Laws about marijuana use" found on the Colorado Official State Web Portal (COSWP) was used to describe laws related to marijuana use in pregnancy. (COSWP, 2017)

JAMA *Pediatrics* also featured another article on the association of state recreational marijuana laws with adolescent marijuana use, which was used to formulate this analysis. This article examined marijuana use and perceived harmfulness of marijuana in adolescents from Colorado and Washington. (Cerdá, et al., 2017) The study evaluated "data of 253 902 students in eighth, 10th, and 12th grades from 2010 to 2015 from Monitoring the Future, a national, annual, cross-sectional survey of students in secondary schools in the contiguous United States" (Cerdá, et al., 2017), and compared the statistics from pre-legalization to post legalization, and against states that had not legalized. (Cerdá, et al., 2017)

Risk perception, or perceived harmfulness of a substance, is a common subject that appears in several of the articles. This is likely due to the fact that lower risk

perception of marijuana use is affiliated with increased risk of marijuana abuse. The following articles mentioned contributed to the risk perception section of this analysis. An article found in the *Journal of Community Health* (Bull, Brooks-Russell, Davis, Roppolo, & Corsi, 2016) reports data on youth attitudes and beliefs on health risks associated with marijuana use, knowledge of marijuana laws, discussions about marijuana with parents, and peer social norms. The data also evaluated demographic differences in perception of risk and knowledge of laws that were also incorporated in this study. A publication in the *Annual Review of Medicine* (Wilkinson, Yarnell, Radhakrishnan, Ball, & D'souza, 2016) provides an overview of marijuana and marijuana use, and proceeds to discuss various public health matters affiliated with marijuana legalization. The study provided information regarding marijuana and driving, and risk perception which were focus points for this analysis.

The impact of recreational marijuana legalization on health care was also a recurring theme throughout the research. The following articles all contributed data on health care impacts to the analysis, particularly emergency department visits. An article found in the *Annals of Emergency Medicine* (Kim & Monte, 2016) evaluated the effect of legalization on Emergency Care. This study evaluated retrospective data from the Colorado Hospital Association, which included over 100 hospitals in the state. Information gained from this article includes number of ED visits related to marijuana use before and after legalization, and information on visits related to Cyclic Vomiting Syndrome (CVS) and Cannabinoid hyperemesis syndrome (CHS). An article found in *GMS German Medical Science* (Blumentrath, Dohrmann, & Ewald, 2017) discusses the recognition, diagnosis, and long-term treatment of CVS and CHS. An article in JAMA

(Monte, Zane, & Heard, 2015) identifies the complex health effects on Colorado citizens, and the expected and unexpected health system effects post legalization of recreational marijuana. (Monte, Zane, & Heard, 2015)

The Marijuana Policy Project (MPP) is recognized as the largest marijuana advocacy group in the U.S., founded in 1995, whose main mission is ending marijuana prohibition. This group claims responsibility "for changing most major state-level marijuana policy reforms since 2000." The MMP recently published an updated report on their site on the impact of marijuana legalization in Colorado. (MPP, 2017) The data is collected from various sources including Colorado government publications, news reports, and peer-reviewed articles. This report supplied statistics on public health impacts, economic impacts, traffic safety, and tax revenue that were interpreted for this analysis.

Similarly, the Marijuana Policy Group (MPG) is a nationally recognized Denver-based economic and policy consulting firm that researches the medical and recreational cannabis market which assists businesses, government agencies, and investors in decision making. Their recent report (Light, Orens, Rowberry, & Saloga, 2016) contributed data on economic impacts.

An article found in *Health Promotion Practice* discussed the Good to Know Campaign, which was Colorado's statewide informational media campaign used to increase residents' knowledge on the marijuana laws, and to educate them on using marijuana legally. This article discussed the results and effectiveness of the Good to Know Campaign, and provides recommendations to other states on obtaining a baseline

awareness of laws. This article was mainly referenced in the discussion section. (Brooks-Russell, Levinson, Li, Roppolo, Bull, 2017)

Data and perspective in this analysis was also found through reading a book called Marijuana Legalization: What Everyone Needs to Know. This book is a second edition, comprehensive analysis on marijuana legalization, and it discusses the various, universal debates associated with it. This book offers insight on how countries that implemented recreational marijuana legalization have been impacted. It includes a dedicated chapter focused on impacts in Colorado and Washington, which was referenced in the discussion and conclusion. (Caulkins, Kilmer, & Kleiman, 2016)

An article found on Stanford's Center on Food Security and the Environment website about the environmental impacts of recreational marijuana legalization was used when formulating the conclusions of this analysis. (Nature Conservancy, 2015)

The various data mentioned provided diverse information and perspectives on the impact of recreational marijuana legalization in Colorado. All data was carefully reviewed and taken in to consideration while constructing this policy analysis. Pertinent data was taken from each article and referenced in the appropriate sections below. The introduction was constructed after reviewing and incorporating general information on marijuana, history, legal status, and uses. The results were broken down by impacts on marijuana use, marijuana use during pregnancy, risk perception, health effects, traffic data, crime, and economic impacts. The summary/recommendations section provided an overview of the introduction and results, and discussed recommendations gathered from

the various articles. The conclusion section summarized the main findings and recommendations from this policy analysis.

Results

Since the legalization of recreational marijuana, the state of Colorado has been monitoring the potential impacts on population health through various approaches. When marijuana was legalized recreationally, funding was allocated to the Colorado Department of Public Health and Environment (CDPHE) and they were mandated to monitor the potential public health impacts of marijuana. Medical marijuana was viewed more as a patient/doctor decision. However, the legalization of recreational marijuana urged a greater focus on potential health effects since it would be more available in the community. With the implementation of 25-2.5-110, C.R.S, the CDPHE was given:

-"Statutory responsibility to: "... monitor changes in drug use patterns, broken down by county and race and ethnicity, and the emerging science and medical information relevant to the health effects associated with marijuana use."

-"... appoint a panel of health care professionals with expertise in cannabinoid physiology to monitor the relevant information."

"... collect Colorado-specific data that reports adverse health events involving marijuana use from the all-payer claims database, hospital discharge data, and behavioral risk factors."'

Following the statute, a 14-member committee was appointed by the CDPHE referred to as the Retail Marijuana Public Health Advisory Committee (RMPHAC). This

committee consisted of individuals in medicine, medical toxicology, public health, and epidemiology that also had displayed expertise in marijuana through their work. This purpose of this committee was to review the scientific evidence and literature on the health effects and impacts of marijuana in Colorado, and to implement a clear, unbiased process for evaluating outcomes and provide recommendations based on these outcomes. They began meeting in May 2014, and the first edition report by the CDPHE was published in January 2015, followed by the second edition on January 30, 2016. The report collected data from several distinguished population-based surveys which included the Behavioral Risk Factor Surveillance System Survey (BRFSSS) (Appendix B), a survey of adults from the Centers for Disease Control and Prevention (CDC); The Child Health Survey (CHS) (Appendix D), The Healthy Kids Colorado Survey (HKCS) (Appendix A), The Pregnancy Risk Assessment Monitoring System Survey (PRAMS) (Appendix C). (RMPHAC, 2017)

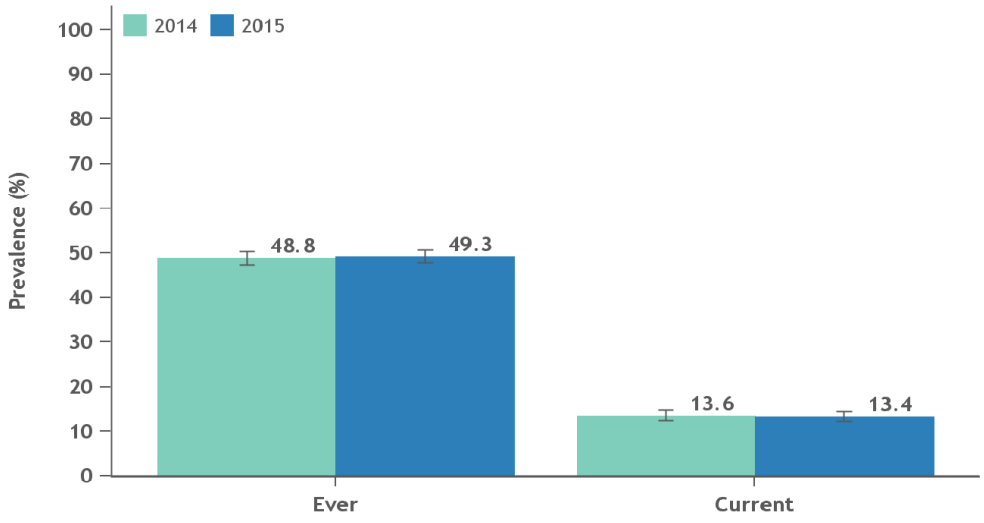
III.1 Impact on Marijuana Use

Marijuana use among adults and adolescents was a concern for many in opposition of Amendment 64. However, according to the Colorado Department of Public Health and Environment (CDPHE), past-month marijuana use among adolescents and adults has not changed in terms of number of users or frequency since legalization. (RMPHAC, 2017)

The trends of marijuana use reflected in the CDPHE report indicates approximately 13% of adults in Colorado ages 18 and up used marijuana in the past-month in 2015. The National Survey on Drug Use and Health (NSDUH) differed at 17%,

however neither statistic was considered a significant change from 2014 (13.6%) to 2015 (13.4%). (Figure 1) (RMPHAC, 2017)

Figure 1. Ever and current marijuana use among Colorado adults (18+ years) 2014-2015

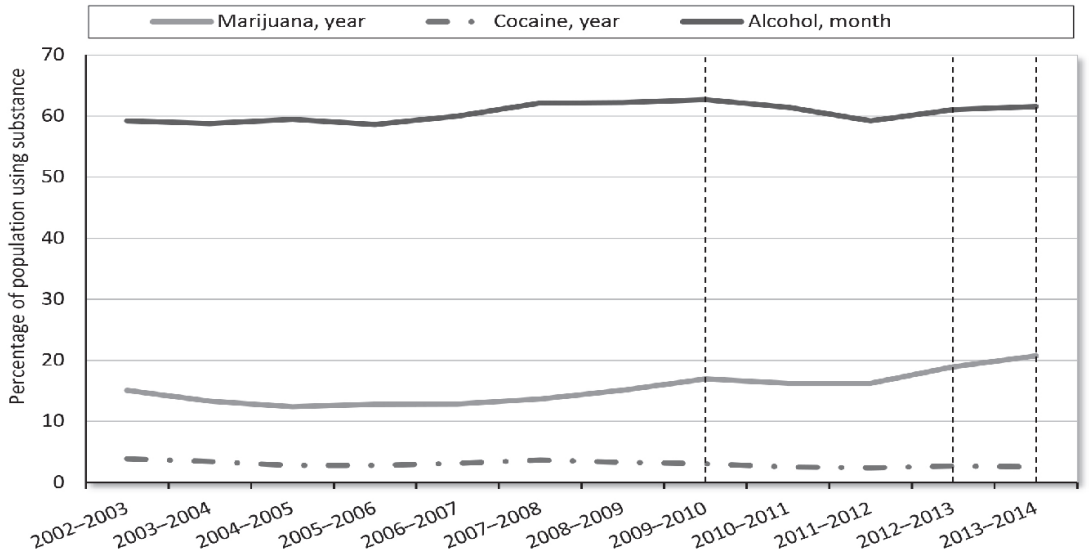


Produced by: EEOHT, CDPHE 2016.*Black bars indicate margins of error (95% Confidence Intervals). †Ever Use was marijuana use at least once in a lifetime. Current Use is defined as marijuana use at least once in the past 30 days.‡Data Source: Colorado Behavioral Risk Factor Surveillance System 2015. **(RMPHAC, 2017)**

The national average of adult marijuana use was 8%. (RMPHAC, 2017). However, data from the National Survey on Drug Use and Health, Substance Abuse and Mental Health Services Administration (SAMHSA) demonstrates that Colorado marijuana usage rates have been modestly growing and have consistently been higher than the national average since prior to 2009, coinciding with the commercialization of medical marijuana. This uptrend in usage rates has continued through 2012, with only minor deviation post legalization. (Figure 2) (Dills, Goffard, & Miron, 2016) The BRFSS report reveals that the highest rate of past month use in 2015 was in adults "18-25 years old (26%); males (17%); and those who reported gay, lesbian, bisexual or other orientation (37%)." Neither of these groups showed a statistical change between 2014

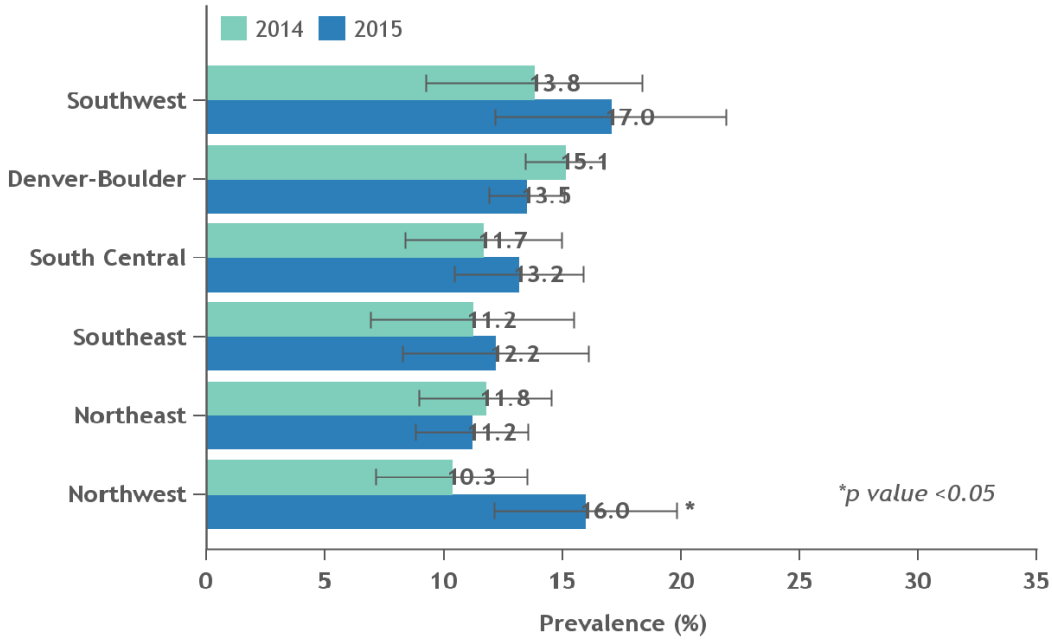
and 2015. The only exception was Northwest Colorado, which had an increase in past-month use from 2014 (10%) to 2015 (16%). No other regions of Colorado showed any statistical changes in use. (Figure 3) (RMPHAC, 2017)

Figure 2: Colorado National Survey on Use and Health Results (all respondents, aged 12+)



Source: National Survey on Drug Use and Health, Substance Abuse and Mental Health Services Administration (SAMHSA).) **obtained from: (Dills, Goffard, & Miron, 2016)**

Figure 3: Current marijuana use among Colorado adults (18+ years) by regions, 2014-2015.

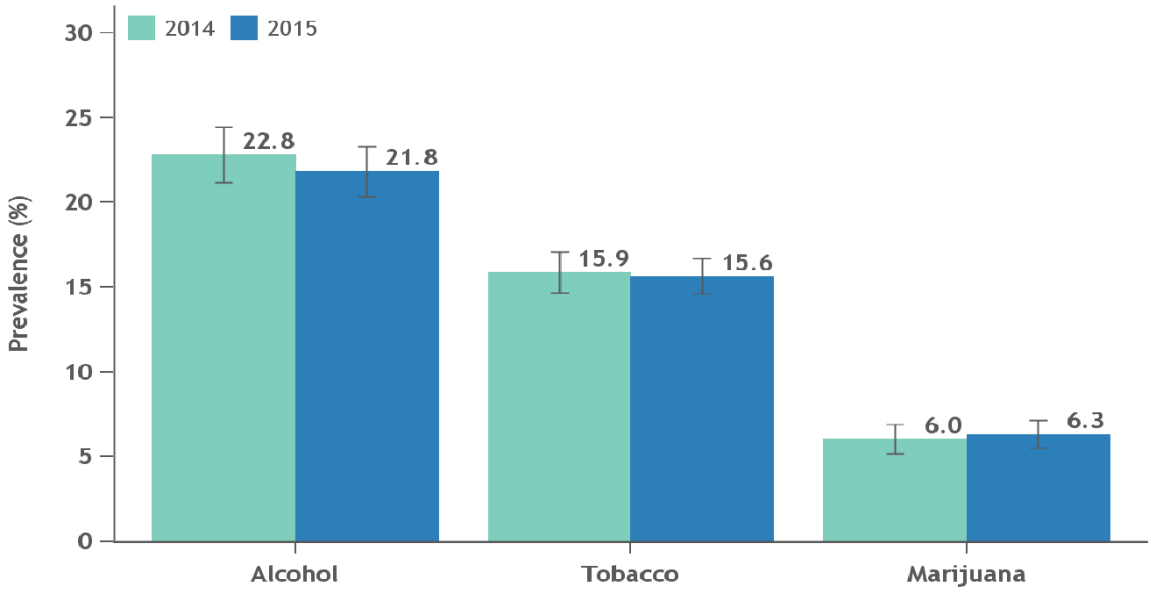


Produced by: EEOHT, CDPHE 2016. †Black bars indicate margins of error (95% Confidence Intervals).

‡Current Use was marijuana use at least once in the past 30 days.
§Data Source: Colorado Behavioral Risk Factor Surveillance System 2015. **(RMPHAC, 2017)**

Regarding daily use, 6% of adults in Colorado report near-daily or daily use of marijuana. This trend is higher than the monthly or weekly use, however, there was no statistical difference in near daily use between 2014 and 2015. It was also noted that marijuana use was statistically lower than alcohol or tobacco abuse, and between 2014 and 2015, there was no significant difference in use across each substance. (Figure 4) (RMPHAC, 2017)

Figure 4. Daily or near daily use of alcohol, tobacco, and marijuana among Colorado adults (18+ years) 2014-2015.



Produced by: EEOHT, CDPHE 2016. *Black bars indicate margins of error (95% Confidence Intervals). †Daily or Near Daily Use is defined as using 20-30 days in the past 30 days (marijuana or alcohol) or reporting everyday or someday use (smoking tobacco).
‡Data Source: Colorado Behavioral Risk Factor Surveillance System 2015. **(RMPHAC, 2017)**

According to the comprehensive data, adolescent marijuana usage in Colorado was almost most identical to the national average. (RMPHAC, 2017) The head of the

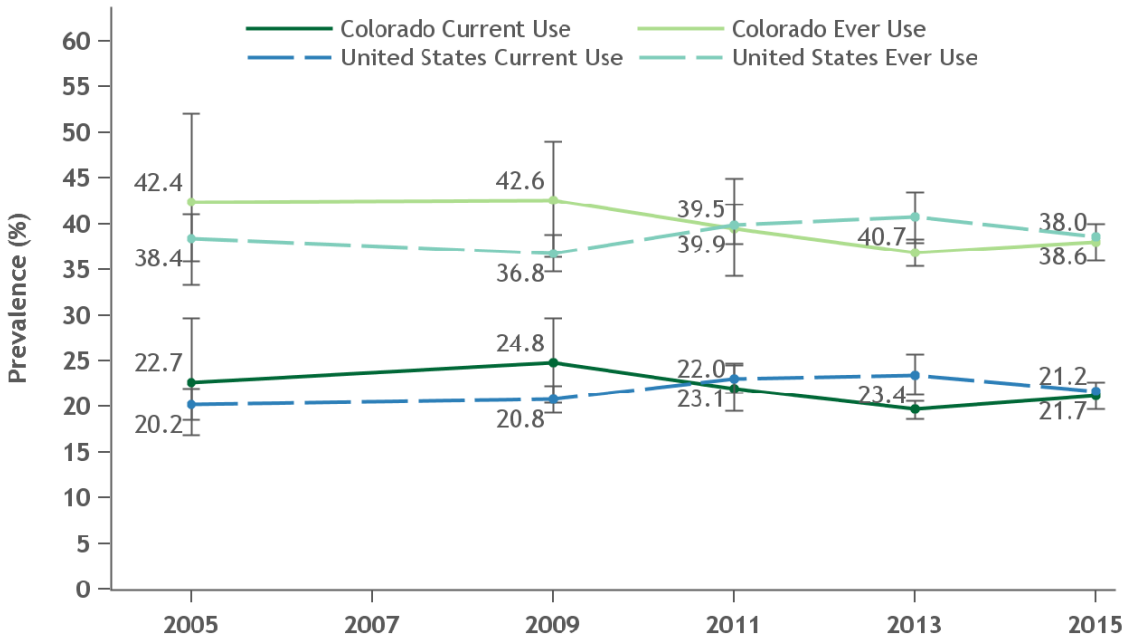
National Institute on Drug Abuse (NIDA), Nora Volkow, also stated that rates of marijuana usage had not risen despite public attitude and policy changes. (MPP, 2017)

Colorado has been monitoring health information of high school and middle school kids in the public health system since 1999. The Healthy Kids Colorado Survey (HKCS) is an anonymous, voluntary survey that is administered in the fall of odd years. (Appendix A) The Colorado Department of Public Health and Environment (CDPHE), the Colorado Department of Education (CDE), and the Colorado Department of Human Services (CDHS) collaborated to make the HKCS in order to collect critical data among Colorado students. This data is available to the communities and schools to promote strategies to protect health and academic achievement in the youth. This data is also submitted to the CDC and is used in the Youth Risk Behavioral Surveillance Survey (YRBS) (Appendix B) which compares Colorado statistics to the national averages. (RMPHAC, 2017)

Recent data from the Healthy Kids Colorado Survey (HKCS) reports that in 2015, 21% of Colorado high school students used marijuana in the past month, which is not statistically different compared to 20% in 2013. (RMPHAC, 2017) Both values had dropped from 22% in 2011, prior to the approval of legalization initiation. (MPP, 2017) These values are also almost identical to the national average reported by the YRBSSS at 22%. However, reports reveal that marijuana use in high school students have fluctuated with no clear trend between 2005-2015 from 20%-25%. (Figure 5) Reports have also shown that between 2005 and 2013, the percentage of current use high school students in Colorado was consistently higher than the national average of high school students. However, in 2013, the difference decreased at 19.7% on HKCS and 17.4% on NSDUH.

(Figure 5) The HKCS also reported that the lifetime use of marijuana use in Colorado high school students dropped from 42.6% in 2009 to 38% in 2015, which was similar to 38.6% nationwide in 2015. (MPP, 2017) Overall, greater than 5% of high school students report daily or near daily use of marijuana, but this number has been stable since 2005. (RMPHAC, 2017)

Figure 5. Prevalence of ever and current marijuana use for high school students in Colorado (HKCS) compared to the national prevalence (YRBS), 2005-2015.

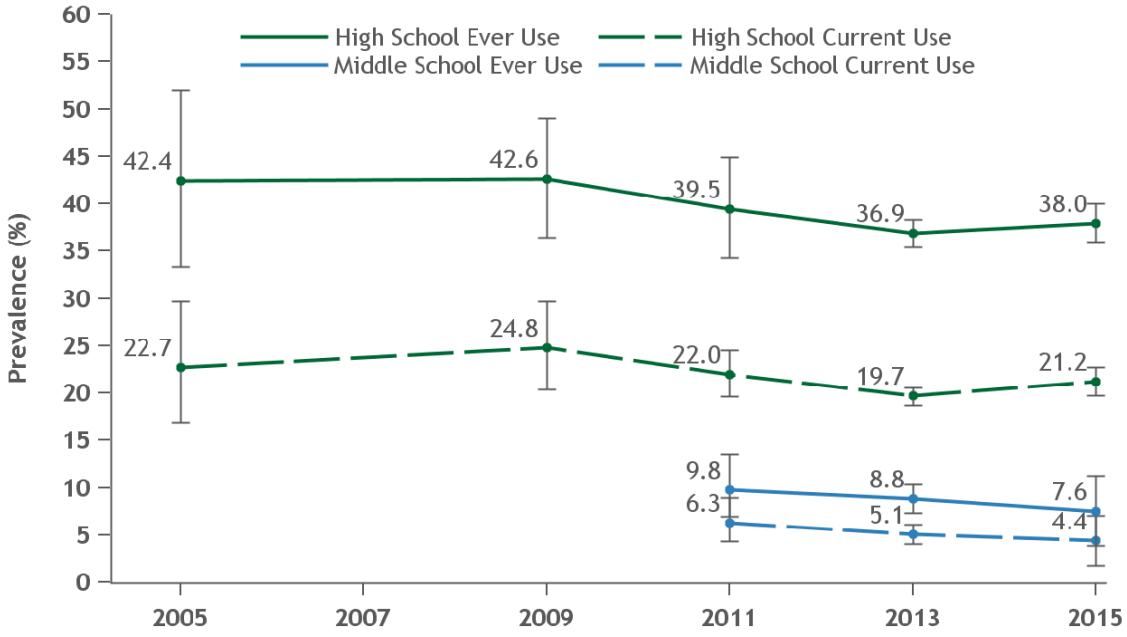


Produced by: EEOHT, CDPHE 2016
*Black bars indicate margins of error (95% Confidence Intervals). †Ever Use is defined as marijuana use at least one time during a student's lifetime and Current Use is defined as marijuana use at least once in the past 30 days. ‡Data Source: Healthy Kids Colorado Survey (HKCS) prevalence estimates for 2005-2015. Data for the year 2007 was not included due to low sample size. Data for middle school marijuana use was not collected before 2011. (RMPHAC, 2017)

The rate of current past-month marijuana use in Colorado middle schools also saw a drop from 5.1% in 2013 to 4.4% in 2015 and there were a less percentage of students that reported it was easy to obtain marijuana at home. An estimated 7.6% of middle

school students report having ever used marijuana in 2015, none of these estimates were found to be statistically significant from 2011-2015. (Figure 6) (RMPHAC, 2017)

Figure 6. Prevalence of ever and current marijuana use for high school and middle school students in Colorado, 2005-2015



Produced by: EEOHT, CDPHE 2016 *Black bars indicate margins of error (95% Confidence Intervals). †Ever Use is defined as marijuana use at least one time during a student's lifetime and Current Use is defined as marijuana use at least once in the past 30 days. ‡Data Source: Healthy Kids Colorado Survey (HKCS) prevalence estimates for 2005-2015. Data for the year 2007 was not included due to low sample size. Data for middle school marijuana use was not collected before 2011. **(RMPHAC, 2017)**

The HKCS also further broke down adolescent (age 14-17) marijuana use by gender, grade levels, race, and sexuality. The data showed that past month adolescent marijuana use was equal among males and females at 21% in 2015. However, there was an increase in current past month use among females from 18% in 2013. When comparing grade levels, high school seniors and juniors had the highest past-month marijuana use at 26% and 28%. Similar to adults, students that identified as bisexual, gay, or lesbian were more likely to report past month marijuana use at 35% versus those who

identified as heterosexual at 20%. Hispanics reported a higher past month use at 24%, versus other races at 28%, and among Caucasians at 20%. (RMPHAC, 2017)

Among high school students, the prevalence of current marijuana use has been consistently lower than current alcohol use from 2009-2015, and it has been higher than current tobacco use from 2011 through 2015. In comparison between 2013 and 2015, current tobacco smoking among high school students was statistically lower in 2015. (Figure 7) (RMPHAC, 2017) Since 2010, the Colorado high school dropout rates significantly decreased, and graduation rates significantly increased. (MPP, 2017)

Figure 7. Prevalence of current marijuana use for high school students in Colorado compared to current alcohol use and tobacco smoking in Colorado, 2009-2015.

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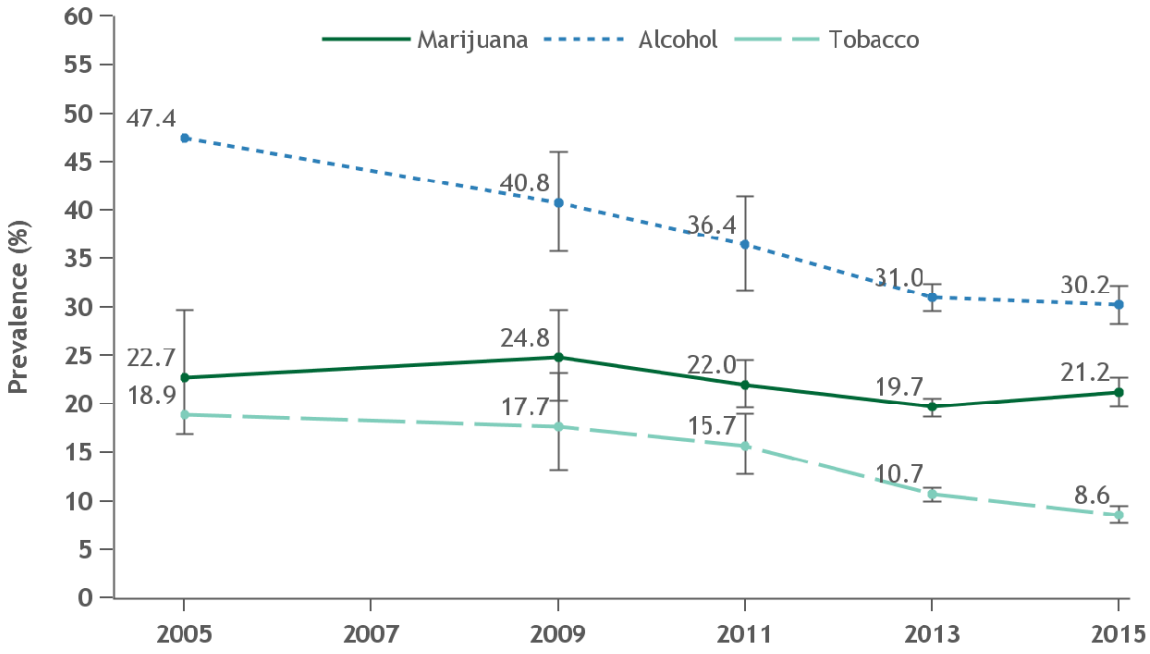


Produced by: EEOHT, CDPHE 2016 *Black bars indicate margins of error (95% Confidence Intervals).
†Current Use is defined as marijuana use at least once in the past 30 days. ‡Data Source: Healthy Kids Colorado Survey (HKCS) prevalence estimates for 2005-2015. Note: Data for the year 2007 was not included due to low sample size **(RAMPHAC, 2017)**

III.2. Impact on Marijuana use During Pregnancy and Breastfeeding

Marijuana use during pregnancy and breastfeeding in Colorado has been monitored through the PRAMS survey. (Appendix C) This survey is sponsored by the Center for Disease Control (CDC) to monitor maternal and child health indicators, and to identify groups of infants and women that may be at high risk for health problems. (RMPHAC, 2017)

The PRAMS results from 2014 reveal that the use of marijuana during pregnancy in Colorado was approximately 6%, which was not statistically different from the national average at 4%. The PRAMS survey revealed that marijuana use during pregnancy was statistically higher among women between 20-24 years old (13%.)

Women with lower than a 12^{th} grade education were also statistically higher in use during pregnancy at 16%, compared to women with some college at 4%. Mothers who intended on becoming pregnant had lower use during pregnancy at 4%, compared to women with unintended pregnancies at 9%. There were no significant differences in marijuana use during pregnancy between races/ethnicity. Alcohol use in pregnancy was statistically significant at 13% compared to marijuana (6%). There was no statistical difference between marijuana use and tobacco use during pregnancy, which was also 6%. The PRAMS survey also revealed that 5% of new mothers used marijuana while they were breastfeeding. (RMPHAC, 2017) Some hospitals now test babies for drugs after they are born, and if it they test positive for THC, the hospital is required to notify child protective services by Colorado law. (COSWP, 2017)

III.3. Impact on Risk Perception

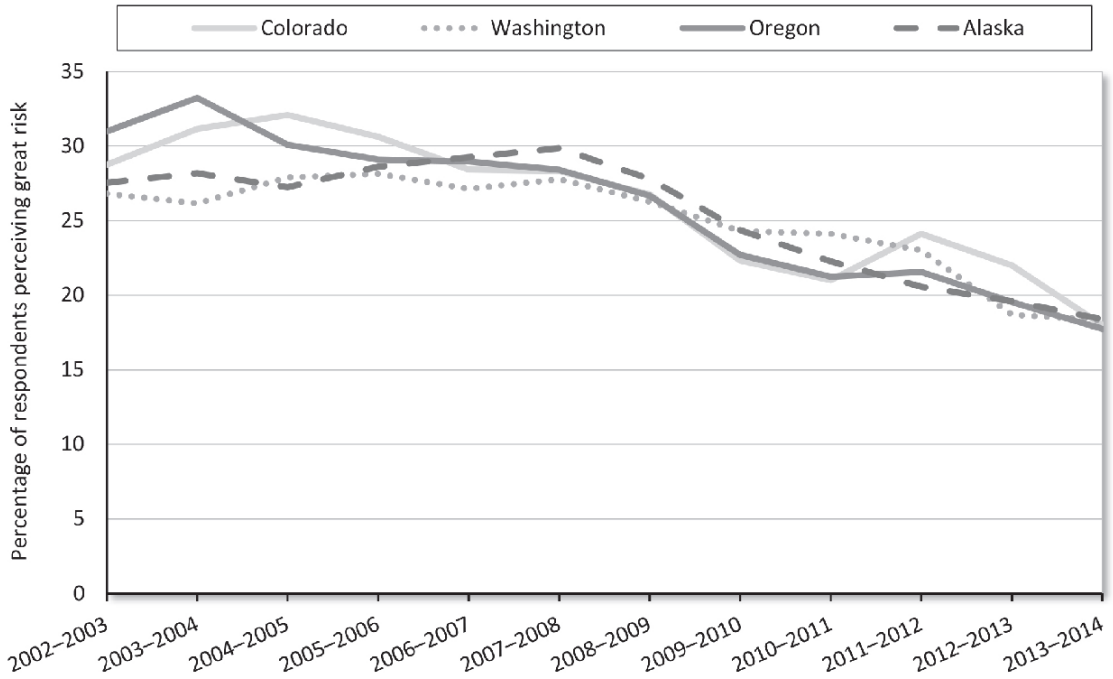
Risk perception, or perceived harmfulness associated with using a substance, is area of concern in states with marijuana legalization, particularly among adolescents. Data from the Monitoring the Future survey has displayed a clear inverse relationship between marijuana use and risk perception among youth. Higher risk perception of marijuana use in younger people is associated with lower rate of use. (Wilkinson, Yarnell, Radhakrishnan, Ball, & D'souza, 2016) Recreational marijuana use in legalized states such as Colorado are limited to adults, however, the effects of legalization on adolescent use is unclear. After the legalization of medical marijuana in certain states, it appeared that adolescent use in those states were higher than non-legal states, however, adolescent use was higher in these states prior to passage of the law and did not appear to increase substantially. (Cerdá, et al., 2017) In the U.S. almost a quarter of youth (age 13-18) report past-month marijuana use. The prevalence of ever using marijuana in the U.S. is 41%, same as cigarette smoking. Nationally, everyday use of marijuana is more common that daily cigarette smoking. This high prevalence is concerning since youth marijuana use is associated with decreased educational success, impaired cognitive ability, and increased risk for marijuana use disorders. (Bull, Brooks-Russell, Davis, Roppolo, & Corsi, 2016)

One article found that perception of risk in youth decreased substantially from 54% in 2013 to 48% in 2015. (Ghosh, et al., 2017) However, an article found in JAMA (Cerdá, et al., 2017) compared adolescent risk perception of marijuana use during the three years before legalization (2010-2012) to the three years after (2013-2015) and found that there was no change in perceived harmfulness among youth in Colorado.

Washington, however, was found to have decreased rate perceived harmfulness and increased past month use among 8th and 10th graders. No significant changes were found among 12th graders in Washington. An explanation could be that Colorado had an advanced medical marijuana dispensary system prior to legalization that youth were exposed to, while Washington did not. Also, rates of marijuana use have been higher, and rates of perceived harmfulness have consistently been lower in Colorado compared to Washington and non-recreational marijuana states before legalization. This could reflect why there may not be significant increases in the short term after RML enactment, and long-term effects on adolescents are still to be evaluated. (Cerdá, et al., 2017)

Policy Analysis 799, published by the Cato Institute, claims that all four states that legalized recreational marijuana demonstrate a steady decrease in risk perception that predates legalization. In Colorado, risk perception grossly appeared to downtrend from 2002-2014, however, during 2013-2014 there was an increase immediately after legalization. (Figure 8) The article attributes this rise to the anti-legalization and public safety campaigns about the dangers of marijuana use surrounding this time frame. (Dills et al., 2016)

Figure 8: Perception of Risk

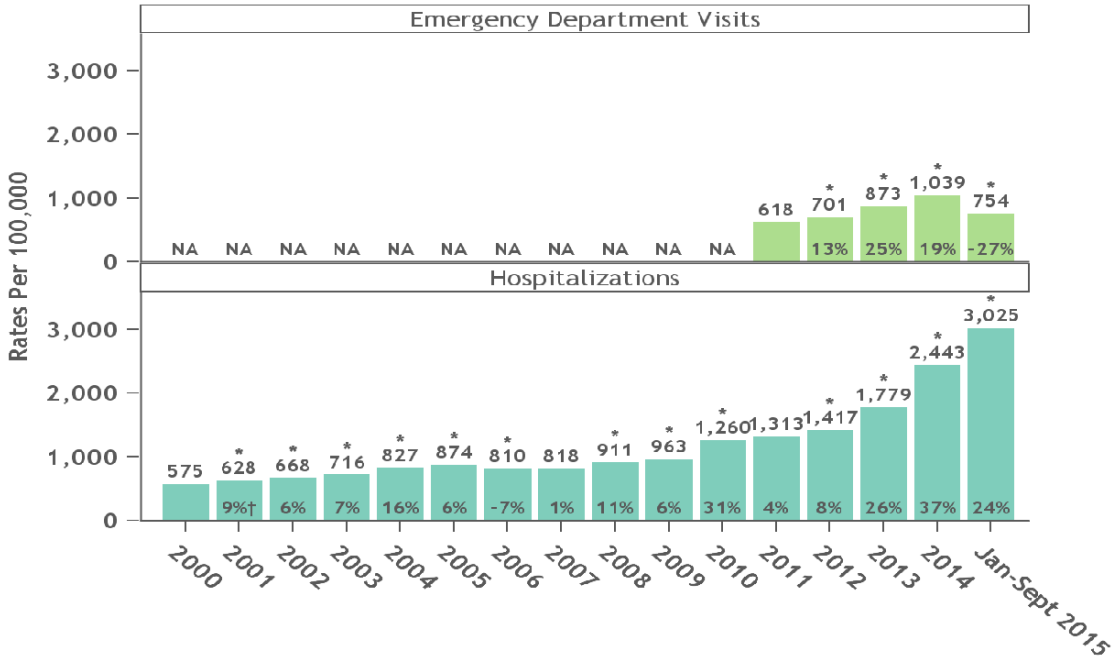


Source: National Survey on Drug Use and Health, Substance Abuse and Mental Health Services Administration (SAMHSA), http://www.samhsa. gov/data/population-data-nsduh/reports?tab=33 . **(Dills et al., 2016)**

III.4. Impact on Health Care Visits and Hospitalizations

One area that showed a definitive change after recreational marijuana legalization was health outcomes related to emergency department visits and hospitalizations. Between 2013 and 2015, there was a 70% increase in hospitalizations with marijuana-related codes. ED visits were found to have increased from 2013 to 2014 by 19%, a disproportionate amount of the increase was seen among tourists. However, between 2014 and 2015, the number of ED visits decreased by 27% to a number lower than in 2013. Marijuana related hospitalizations remained much lower overall compared to alcohol related ED visits and hospitalizations. (Figure 9) (Ghosh, et al., 2017)

Figure 9. Rates of hospitalizations (HD) and emergency department (ED) visits with marijuana-related billing codes in Colorado.



Produced by: EEOHT, CDPHE 2016*Rate significantly increased from previous time period with a p-value <0.001.†The percent change in rates of HD and ED visits compared to the previous year. ‡ICD-9-CM codes 305.20-305.23, 304.30-304.33, 969.6, and E854.1 were used to determine HD and ED visits with marijuana related billing codes. §Data Source: Colorado Hospital Association 2000-Sept 2015 (2011-Sept 2015 for ED visits). **(RMPHAC, 2017)**

Poison Center calls were also noted to have increased post legalization. The Rocky Mountain Poison and Drug Center (RMPDC) tracks public information regarding toxicity, disease related exposures, and injuries, and reports it to health care providers. RMPDC has been assisting and providing information to Colorado for over 50 years and participates in the American Association of Poison Control Center's National Poison Data System. From 2000-2016, there were a total of 1,688 human marijuana exposure calls. The numbers between 2000-2009 were relatively stable, and in 2010 after commercialization of medical marijuana, there was a two-fold increase in marijuana exposure calls from 44 to 93. Another insignificant increase occurred between 2010 and 2013 from 93 to 127. In 2014, there was a significant increase in marijuana exposure calls compared to 2013 by 73.8%, 127 to 222. These numbers have remained relatively

constant since 2014, with a slight, non-significant decrease in number of calls to 201 in 2016. These numbers reflect overall intentional and unintentional marijuana exposures, with both groups showing similar results when stratified. (Figure 10) In 2010, the highest increase in unintentional marijuana exposures was found in children 0-8 years old, and the highest increase in intentional marijuana exposure calls were in adults aged 25 and over. (Figure 11) On July 1, 2014, RMPDC began monitoring the type of marijuana involved in exposure cases. The data was limited to July 2014 to December 31, 201, in which there were 529 total marijuana exposure calls. Among the total amount of calls, 38.8% were edibles, 37.6% smokeables, and 24.0% were other marijuana products. Over half the calls for children aged 0-8 years old were for edible marijuana products at 54.5%, following smokeables (25%) and other (23%). (Figure 12) (RMPHAC, 2017)

Figure 10: Number of marijuana exposure calls to poison center by marijuana only and marijuana with other substances in Colorado

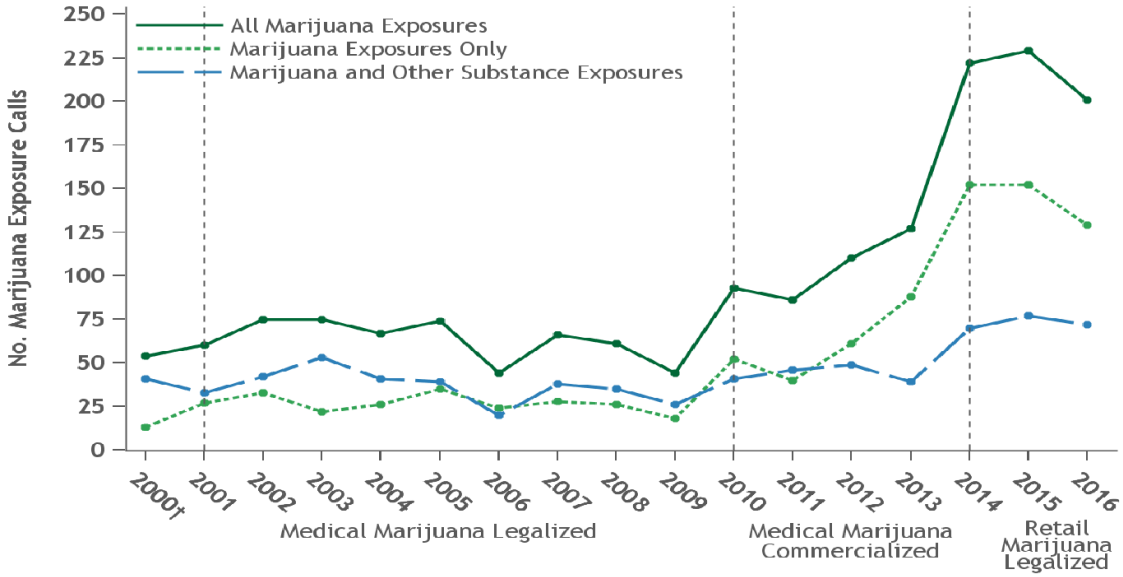
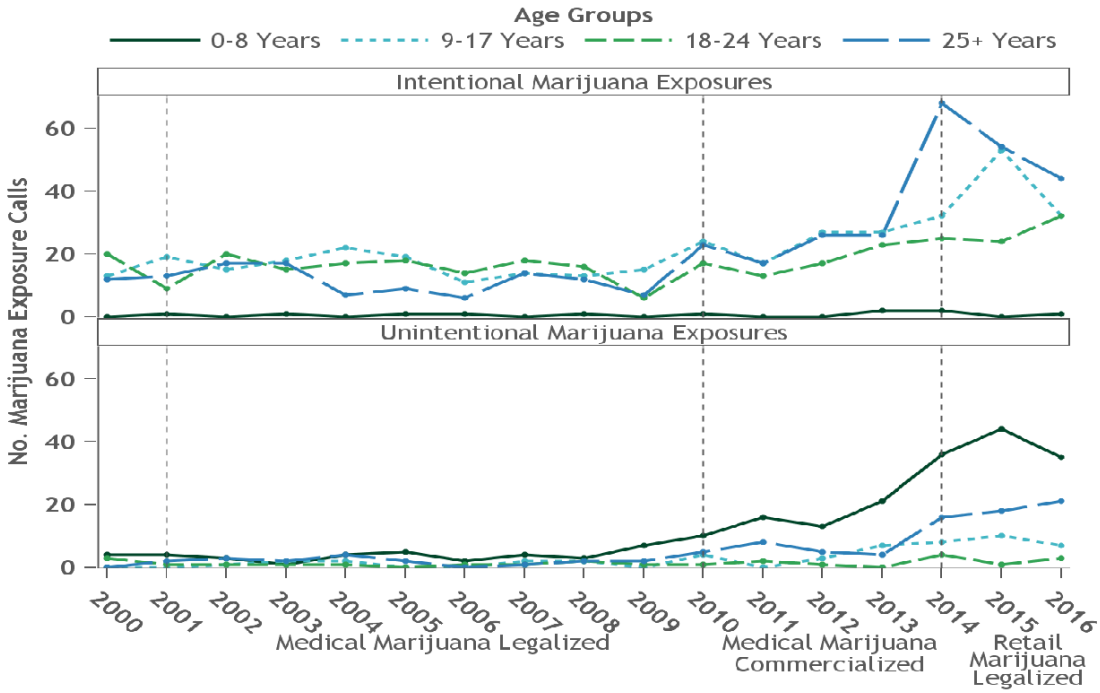


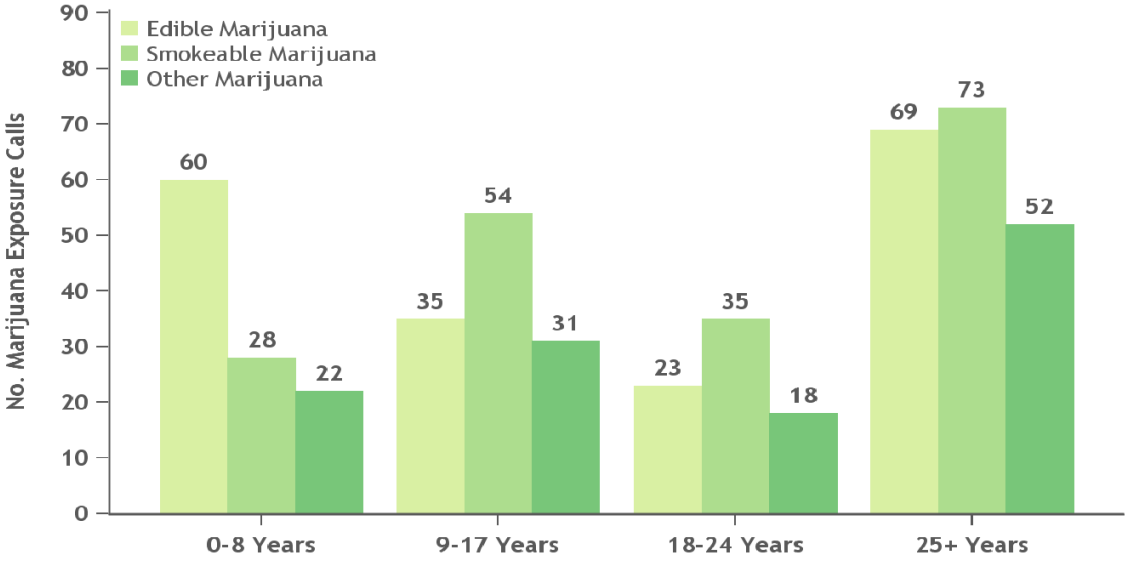
Figure 10: Produced by: EEOHT, CDPHE 2016. *Counts significantly increased from previous year with a p value <0.003. †Prior to legalized medical marijuana. ‡Data Source: National Poison Data System (NPDS) closed, human, marijuana exposure calls in Colorado from 2000 to 2016, n=1,688. **(RMPHAC, 2017)**

Figure 11: Number of marijuana exposure calls to poison center by intention and age groups in Colorado



Produced by: EEOHT, CDPHE 2016. †Data Source: National Poison Data System (NPDS) closed, human, marijuana exposure calls in Colorado from 2000 to 2016, n=1,437. . **(RMPHAC, 2017)**

Figure 12: Number of marijuana exposure calls to poison center by marijuana type and age groups in Colorado, July 2014 to December 2016



Produced by: EEOHT, CDPHE 2016. †There were 29 calls not shown due to unknown age. ‡Data Source: National Poison Data System (NPDS) closed, human, marijuana exposure calls in Colorado from 2000 to 2016, n=529. . **(RMPHAC, 2017)**

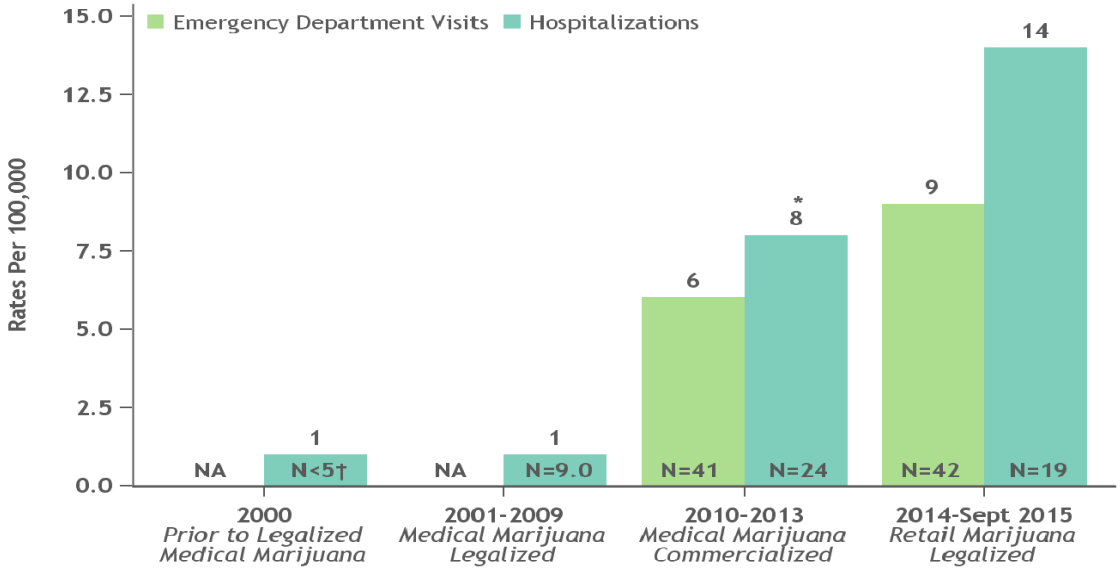
Edibles were originally found to be a much larger problem than anticipated when marijuana was legalized recreationally in Colorado. In 2015, the commercialization of

medical and recreational marijuana generated over $900 million in sales, marijuana edibles were a significant portion of the revenue. They are often similar in appearance and taste to their equivalent food product, which led to a significant number of unintentional exposures, specifically in the pediatric population. Prior to newer dosage regulations now in place, THC concentrations ranged from 5 to over 100 mg in a single brownie, candy, or cookie which led to a significant increase in unintentional ED visits, hospitalizations, and regional poison center calls. According to study in the Journal of Medical Toxicology, a regional Colorado Children's Hospital saw a significant increase in emergency visits after medical marijuana legalization in 2009. Previously, there were no visits for children <12 years old for marijuana exposures between 2005 and 2009. However, after 2009, there were 14 ED visits, 8 of them related to edibles. Of these 14 visits, 57% were admitted, two of which went to the intensive care unit with CNS depression and respiratory failure. (Wang, 2016)

Since 2009, the rates of hospitalizations, ED visits, and marijuana related poisonings in children less than 9 years old have increased over time, with a significant surge after medical marijuana commercialization in 2010. Another increase occurred in 2014 and 2015, the rate was 14 per 100,000 hospitalizations and 9 per 100,000 ED visits, rates higher in urban areas versus rural areas. (Figure 13) (RMPHAC, 2017) Data showed strong evidence that states with increased legal access to marijuana had a higher number of unintentional marijuana exposures in children. (Map 1. see Appendix E) (RMPHAC, 2017) An article in JAMA evaluated pediatric admissions at Children's Hospital Colorado, Aurora and regional poison center (RPC) for marijuana exposures in children 0-9 between 2009 and 2015. The results indicated a higher number in RPC cases and

hospital visits in the two years prior to the legalization of recreational marijuana and two years after. The rate of RPC cases increased significantly at 34% per year, compared to the U.S at 19% per year. Approximately 50% of the pediatric patients seen 2 years after legalization were recreational marijuana exposures, which indicated that legalization did impact incidence of exposures. The majority of exposure sites were the children's own residence at 88%. The overall amount of unintentional pediatric marijuana exposures remains small compared to the total amount of pediatric exposures and ingestions presenting to the RPC and ED. However, with increase in marijuana availability, unintentional marijuana exposures in pediatric population may continue to rise. Marijuana exposure symptoms can also be more severe than other exposures, which resulted in 35% of patients requiring admission, and increasing hospital financial resources and burdens. (Wang, et al., 2016)

Figure 13. Children under 9 years of age; Rates of hospitalizations (HD) and emergency department (ED) visits with poisoning possibly due to marijuana in Colorado



Produced by: EEOHT, CDPHE 2016 *Rate significantly increased from previous time period with a p-value <0.001. †ICD-9-CM codes 969.6 and E854.1, poisoning and accidental poisoning by psychodysleptics, were used to determine HD and ED visits with poisonings possibly due to marijuana. ‡The Ns are the total number of HD or ED visits with poisoning possibly due to marijuana in the specified time period. §Data Source: Colorado Hospital Association 2000-Sept 2015 (2011-Sept 2015 for ED visits). **(RMPHAC, 2017)**

Four high profile deaths post-legalization, related to violence or injuries after consuming edibles, prompted significant policy changes in Colorado. The state strengthened policy efforts in several areas, particularly in edible safety regulations. Childproof packaging requirements had previously been in effect; however, in 2015 limitations on maximum THC levels per package were implemented. Other policy efforts included stricter packaging, clearly marked serving sizes, universal symbols, and restrictions on packages that may be appealing to children. (Ghosh, et al., 2017)

Other unexpected health concerns were increased prevalence of burns and cyclic vomiting syndrome. According to an article in JAMA (Monte, Zane, & Heard, 2015) the University of Colorado Burn Center noticed a significant increase in number of marijuana related burns post legalization. From 2013 to 2015, the burn center had 31 marijuana related admissions, some involving greater than 70% of body surface areas and 21 requiring skin grafting. These burns had occurred from using butane during THC extraction from the marijuana plants. (Monte, Zane, & Heard, 2015).

Cyclic vomiting syndrome (CVS) and cannabinoid hyperemesis syndrome (CHS) can occur in those who chronically use high TCH concentrated products (Kim & Monte, 2016), and have likely contributed to the increases in emergency department visits in Colorado. It presents as a vomiting, diaphoresis, and severe abdominal pain, and both syndromes are unfamiliar to many physicians. (Blumentrath, Dohrmann, & Ewald, 2017). A study from two Denver area hospitals demonstrated twice as many visits to ED for CVS in 2009 after the legalization of medical marijuana in Colorado, (41 per 113, 263 visits pre-legalization versus 87 per 129,095 visits post legalization.) (Kim & Monte,

2016). CVS case statistics post recreational marijuana legalization are not readily available at this time.

III.5 Impact on Traffic and Motor Vehicle Accidents

The most commonly reported illicit drug reported in motor vehicle accidents (MVA) is marijuana, making the impact of marijuana legalization on traffic relevant. The varied effects of THC on driving abilities, such as absorption, tolerance, and smoking technique, make it difficult to establish a causal relationship between many of these accidents. The relationship between acute marijuana intoxication and MVA is varied, but not as strong as alcohol intoxication and MVAs. One study (Wilkinson et al., 2016) revealed that the amount of fatal MVAs related to cannabis appeared to be increasing after the legalization of medical marijuana in 2009. States without medical marijuana legalization did not see a similar trend. However, during this study, the number of MVA fatalities in Colorado had been on the decline since 2004 and the increase could be related to the general increase in cannabis use. Furthermore, there is no clear indication on whether testing marijuana positive was the cause of the accident. (Wilkinson et al., 2016)

Between 2013 and 2015, driver fatalities that tested positive for marijuana increased by 80%, 55 to 99. Of these incidences, 42% included alcohol in 2013 and 35% in 2015. These increases could have been due to changes in testing practices, and additionally, the data did not specify whether or not the driver was at fault or impaired. The lack of full toxicology reports with each fatality, arrest, or accident identifies limitations to this data. This also demonstrated the importance in obtaining complete reports to accurately assess the impact of impaired driving related to marijuana. (Ghosh, et al., 2017) Colorado has

since made improvements in their Fatality Analysis Reporting System (FARS) data and have implemented law enforcement trainings to detect impairment. (Reed, 2016)

The Colorado Department of Safety reports that since the legalization of marijuana, Driving Under the Influence of Drugs (DUID) has been receiving an increased amount of attention for many reasons. The current statutes and charges do not differentiate whether or not the DUI applies to alcohol, drugs, or both. Toxicology reports are difficult to link to court cases, and law enforcements may choose not to further investigate toxicology if the blood alcohol content is greater than the Colorado limit 0.08. Colorado allows a limit of 5 ng/ml of delta 9-THC in whole blood, which can establish if a defendant is under the influence of one or more drugs. However, if a suspect is arrested due to probable impairment, a warrant must be obtained in order to draw the suspect's blood for a toxicology screen. The delta 9-THC levels decline rapidly after the first hour, making it difficult to be obtained promptly. The Colorado Task Force on Drunk and Impaired Driving have been working to conduct research on this topic, and the Colorado State Patrol initiated a pilot program in 2015 that use oral fluid devices to test THC in saliva. The number of peace officers trained to identify driving impairment from drugs other than alcohol has also increased significantly from 2012 to 2015. (Reed, 2016).

The Colorado State Patrol (CPS) has more drug recognition experts than any other law enforcement agency in the state and is considered the best agency to use for matters regarding impaired driving in Colorado. Approximately 20% of DUI arrests in Colorado are from the CPS, and at the beginning of 2014, they started collecting data on the perceived impairing substance of drivers. Their data revealed a drop in total number of DUIs by 18% between 2014 and 2015, from 5,546 to 4,546. Marijuana or marijuana-in-

combination subpoenas decreased by 1% to 9, and the number of alcohol only subpoenas decreased by 18% to 988. The amount of all DUI cases where marijuana or marijuana-in-combination (marijuana only, marijuana and alcohol, and marijuana and other drugs) was acknowledged as the impairing substance increased from 2014 to 2015, 12% to 15%. (Reed, 2016)

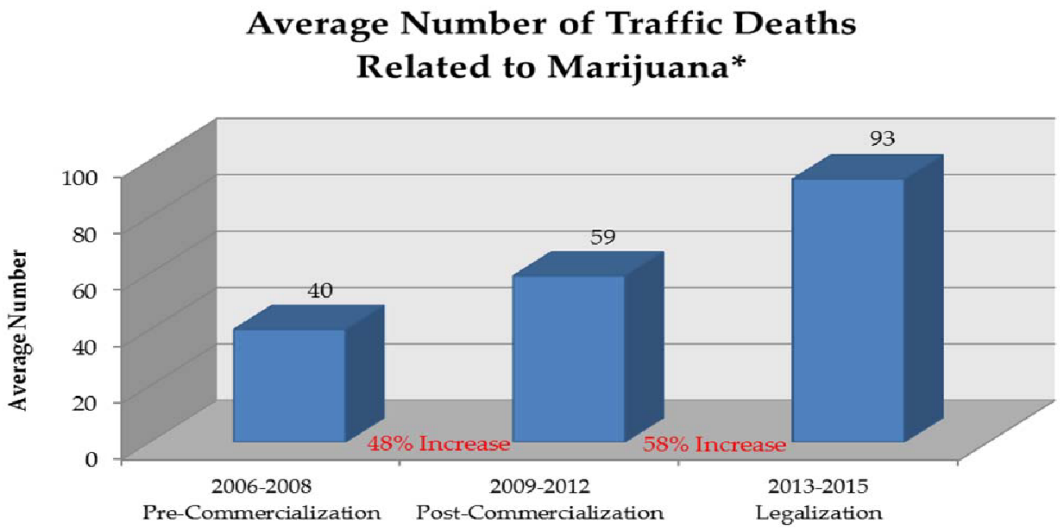
The Denver Police Department claims that the amount of DUI cases involving marijuana or marijuana-in-combination is low, but increased between 2013 and 2015 from 33 to 73. These cases accounted for 2.5% of all DUI citations in Denver in 2014, and increased to 3% in 2015. Drivers found guilty of DUI are required to attend treatment classes before their license can be reinstated. (Reed, 2016) According to the Colorado State Patrol Data, there was a 16% higher amount of marijuana related DUI's in the first 10 months of 2016 compared to the same time frame in 2014. (Ghosh, et al., 2017)

The Marijuana Policy Project (MPP, 2017), the largest marijuana advocacy group in the U.S., reports that the whole nation, including Colorado, saw an increase in traffic fatalities in 2015 and 2016. The article also claims the Colorado state officials did not mention marijuana as a causal factor, and it attributes the increase to not wearing seatbelts, "'Epidemic of distracted driving'", and higher amount of motor cycle accidents. The National Safety Council attributes the increase in traffic fatalities to lower gas prices leading to more miles being driven. MPP further claims that several states without marijuana legalization saw an increase in traffic fatalities compared to Colorado, and noted that Washington saw a slight decrease. The Colorado Department of Transportation data revealed approximately the same amount of traffic fatalities in 2016 at 605 compared to 2005 at 606. Of the 605 fatalities, 59 of the drivers tested positive for

marijuana, however, whether or not the driver was impaired or at fault is not indicated. (MPP, 2017)

The Rocky Mountain High Intensity Drug Trafficking Area (RMHIDTA) partnered with the Colorado Department of Transportation in 2013 to improve collection of toxicology data. (Reed, 2016) The RMHIDTA report claims a 48% increase in marijuana-related traffic deaths during the three-year average (2013-2015) after legalization of recreational marijuana in Colorado compared to the three-year average prior to legalization (2010-2012). An 11% increase in all traffic deaths occurred during the same time period. (Figure 14) (Wong, Clarke, & Harlow, 2016). The MPP also describes the Rocky Mountain High Intensity Drug Trafficking Area (RMHIDTA) as an agency that is against marijuana policy reforms, and claims that journalists have found the agency's annual marijuana related traffic reports misleading. (MPP, 2017)

Figure 14:



SOURCE: National Highway Traffic Safety Administration, Fatality Analysis Reporting System (FARS),2006- 2011 and Colorado Department of Transportation 2012- 2015 **(Wong, Clarke, & Harlow, 2016)**

III.6 Impact on Crime

The impact of legalized recreational marijuana on crime and public safety was an area of concern among district attorneys, law enforcement officials, legislatures, and other public safety stakeholders. The potential impacts were unknown since no state in the U.S. had yet legalized recreational marijuana. (Reed, 2016) Proponents believed that legalizing marijuana would divert black market sales to legal market which would lead to less crime. Advocates also believe that legalization would allow law enforcement to focus on larger crimes by reducing the burden of patrolling for drug offenses. (Dills, et al., 2016)

Opponents of marijuana legalization believe that substances, such as marijuana, can have psychopharmacological effects that can cause crime and associate it with social deviancy. Another fear among governors, policy makers, police chiefs, and citizens was that commercialization of legal marijuana could lead to an increase in marijuana commerce in violent underground markets, and could also make it easier to smuggle across borders where it is prohibited. (Dills, et al., 2016)

According to the Colorado Department of Public Safety (CDPS), "the total amount of marijuana arrests decreased by 46% between 2012 and 2014, from 12, 894 to 7,004." Marijuana possession arrests, the most common among all marijuana arrests, were reduced nearly half at 47%. Marijuana sales arrests also decreased by 24%, and the number of unspecified marijuana arrests decreased by 42%. In 2012, marijuana arrests made up 6% of all arrests in Colorado, and 3% in 2014. (Reed, 2016)

Data from the Colorado State Judicial Branch's data system was collected regarding marijuana filings between 2006 and 2015. This information included County and District Courts throughout the state, excluding Denver County Court. Between 2012 and 2015, the total amount of marijuana-related filings decreased by 81%, from 10,340 to 1,954. Total amount of felonies declined 45%, petty offenses decreased 89%, and misdemeanors declined 1%. The total amount of charges of marijuana possession dropped 88%, distribution decreased 23%, possession with intent to distribute declined 4%, manufacture dropped 68%, and conspiracy decreased 48%. There was a noted increase in public consumption filings in 2013 and 2014, however, filings dropped in 2015 which resulted in no significant change between 2012 and 2015. The defendants were categorized into three age groups that all experienced a substantial decline in marijuana filings between 2012 and 2015. The first age group 10-17 years old declined by 69%, 18-20 years old by 78%, and age 21 and older decreased by 86%. (Reed, 2016)

The Denver County Court processes misdemeanors and petty offenses separately from the State judicial data system. Data from the Denver County Court revealed that the amount of marijuana filings remains stable overall, with an insignificant increase by 18 from 2014 to 2015. They did find a difference in the types of filings, which included "an increase in public consumption and offenses within 1,000 feet of schools, and a decrease for minor in possession and offenses around the 16th Street Mall." (Reed, 2016)

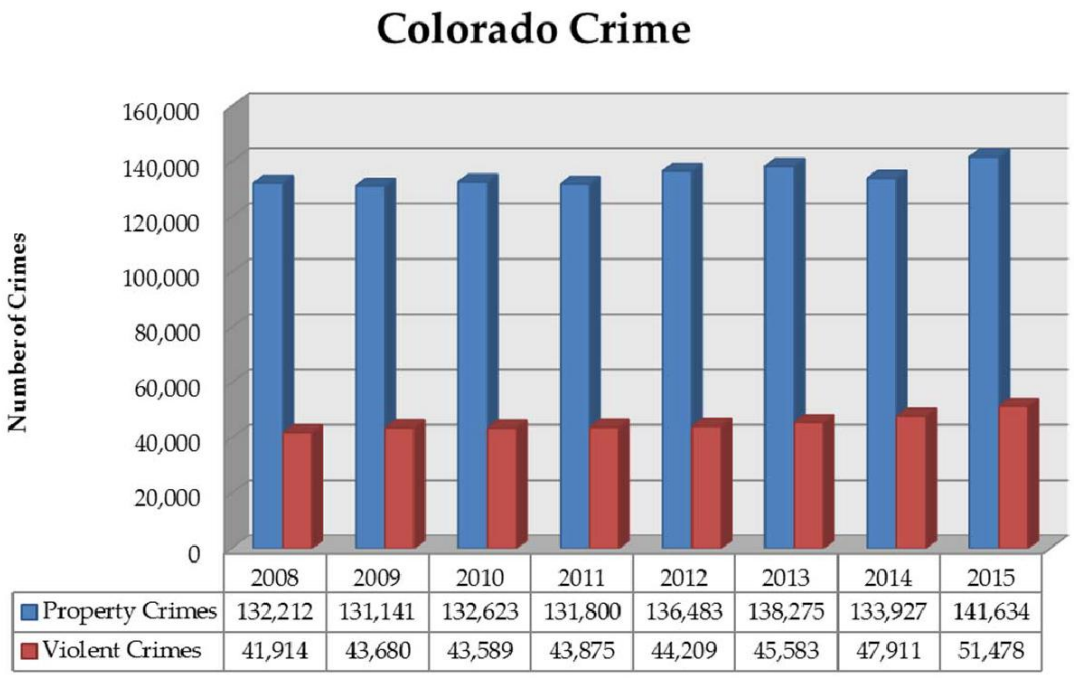
The state of Colorado does not have a statewide database to specify location of all reported crimes, making crimes around marijuana establishments difficult to measure. The Denver Police Department started a project that reviews all reported crime to determine if it is related to marijuana, and furthermore, it codes crimes related to the

marijuana industry. The data indicates that the total amount of industry related crimes make a small portion of overall crime in Denver, and has remained stable from 2012 to 2015. Burglary is the most common industry related crime and accounts for 62% of all industry related crime. The industry being cash-only raised concern of possible increased robberies; however, this has not been the case thus far. (Reed, 2016)

The CDPS reports that non-industry related marijuana crimes are small in number, and have remained stable. In 2015, Robbery made up 33% of non-industry crimes, burglary accounted for 30%, and larceny/theft at 20%. (Reed, 2016)

Marijuana Policy Project (MPP) states, "'Colorado government and law enforcement officials have repeatedly stated that there is not enough data to draw any conclusions about what impact, if any, the state's marijuana laws are having on crime rates.'" Their report also states that there is no evidence of increase in crimes related to marijuana use. MPP included statistics from the Colorado Bureau of Investigation in their report that states the rates of robberies, burglaries, and homicides were approximately the same in 2015 as they were in 2009. (MPP, 2017) The RMHIDTA reported an increase in crime in Denver and Colorado from 2013 to 2015. Their report claims a 6.2% percent increase in all Colorado crime and property crime from 2014 to 2015, and a 6.7% increase in violent crime during the same period. (Figure 15) The report further breaks down reported crimes from 2014 to 2015, and claims crimes against persons increased 7.5%, crimes against property increased 6%, crimes against society increased 15.6%, all other offenses decreased 5.7%, and all Denver crimes increased 4.1%. (Wong, et al.,2016)

Figure 15:



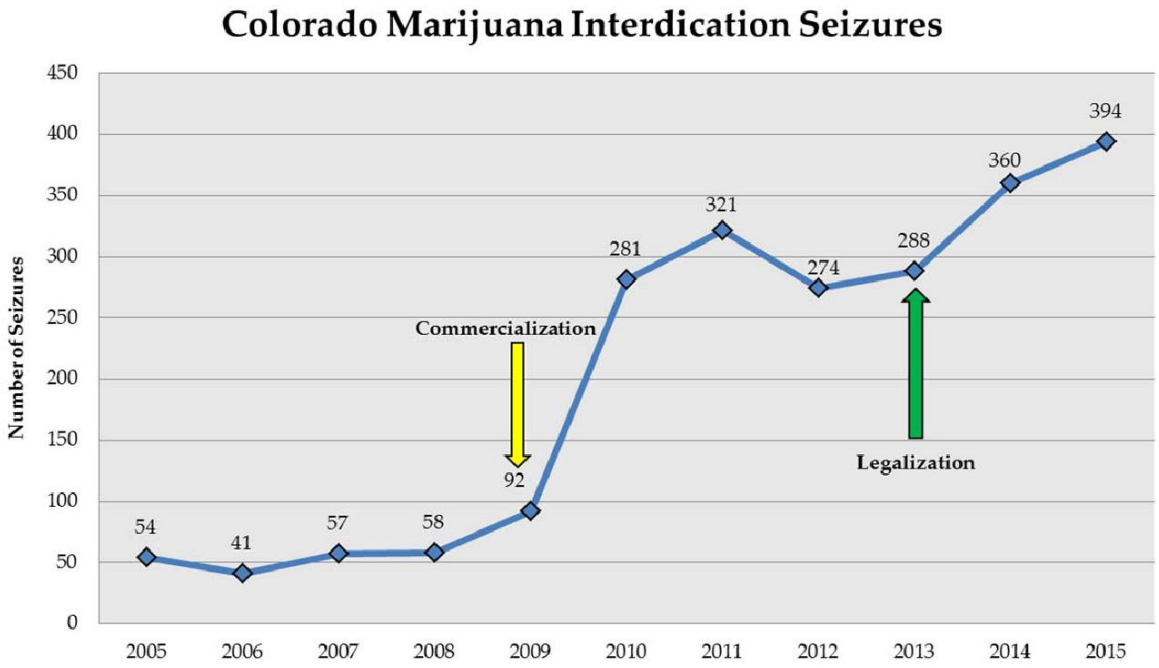
	2008	2009	2010	2011	2012	2013	2014	2015
Property Crimes	132,212	131,141	132,623	131,800	136,483	138,275	133,927	141,634
Violent Crimes	41,914	43,680	43,589	43,875	44,209	45,583	47,911	51,478

Source: Colorado Bureau of Investigation, http://crimenco.cbi.state.co.us/ **(Wong, et al.,2016)**

Diversion of Colorado Marijuana to other parts of the country was also a concern that came with legalization. When medical marijuana was commercialized, 2009-2012, there was a 357% increase of yearly average number of interdiction seizures of Colorado marijuana from 54 to 242 per year. (Figure 16) After recreational legalization, 2013-2015, interdiction seizures increased 37% from 288 to 394. Between 2005 and 2008, a total average of 2,763 pounds of Colorado marijuana was seized, which increased by 30% to 3,586 pounds from 2009-2015. (Figure 17) In 2015, 36 different states were destined to receive the 394 Colorado marijuana seizures, with Illinois, Texas, Iowa, Florida and Missouri identified as the most common destinations. (Figure 18) More than 50% of the Colorado marijuana seizures came from Denver. Since the legalization of recreational marijuana, The U.S mail also saw a 427% increase in diversion of Colorado

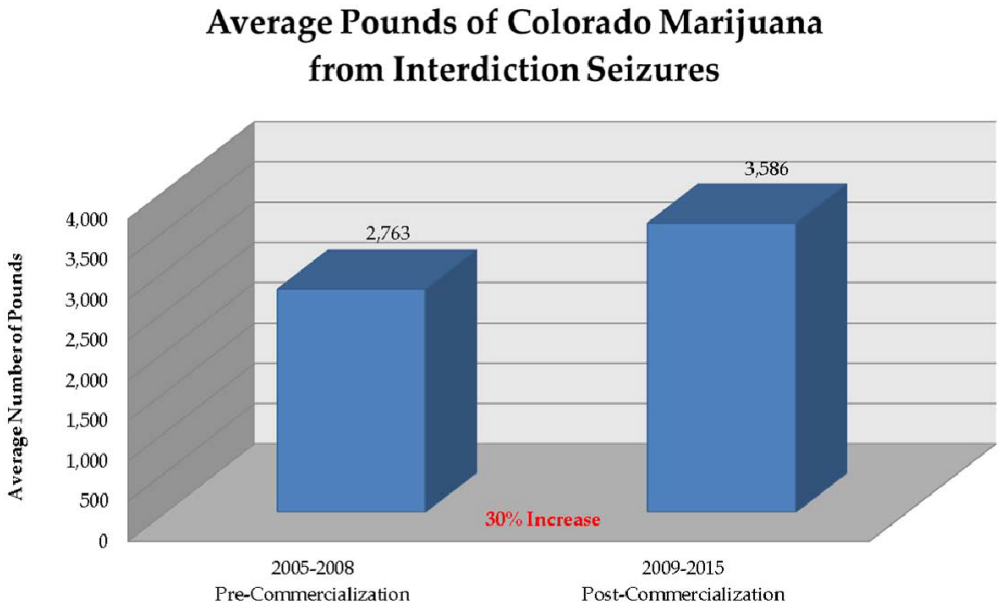
marijuana by parcel from 70 in 2010-2012 to 369 in 2013-2015. There was also a 471% increase in average pounds of Colorado marijuana parcel seizures from 129 pounds during 2010-2012 to 736 pounds from 2013-2015. (Wong, et al., 2016)

Figure 16:



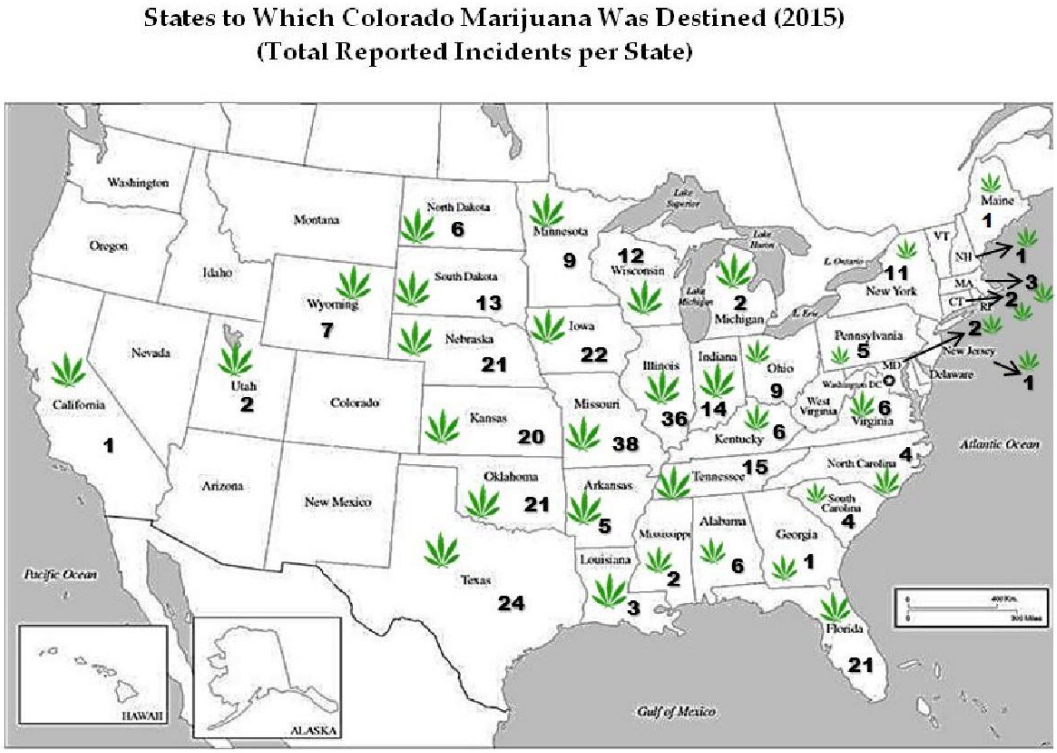
Source: El Paso Intelligence Center, National Seizure System, as of August 15, 2016 **(Wong, et al., 2016)**

Figure 17:



Source: El Paso Intelligence Center, National Seizure System, as of August 15, 2016 (**Wong, et al., 2016)**

Figure 18:



Source: El Paso Intelligence Center, National Seizure System, as of August 15, 2016 (**Wong, et al., 2016)**

III.7 Impact on Economy

Prior to the legalization of marijuana, advocates believed that legalizing marijuana would increase tax revenue, stimulate the economy by creating jobs in the marijuana industry, and enhance “"marijuana tourism"”. Many also believed that there would be an influx of residents that would move to take advantage of the “loose marijuana laws”, therefore leading to a soar in the housing market. (Dills, et al., 2016)

Colorado Department of Public Safety (CDPS) obtained data from the Colorado Department of Revenue (CDOR) and found an increase of 77% in total revenue from licenses, taxes, and fees from calendar year 2014 to 2015, $76,152,468 to $135,100,465. Retail marijuana taxes, licenses, and fees account for the majority of the increases, and total retail marijuana revenue accounted for 81%, or $108,783,986, of all marijuana revenue. The passing of Amendment 64 was estimated to increase excise tax revenue to fund public school capital construction by $40 million, and in 2015, it nearly reached the goal at $35,060,590 during the calendar year. This reflected an increase from 2014 by 163%. Taxes distributed to the local government also saw an increase by 89%, from $4,553,122 to $8,626,922. However, gross tax revenue collections in Colorado totaled $14.2 billion in fiscal year 2015, and marijuana taxes comprise approximately 0.95% of the total collections. (Reed, 2016)

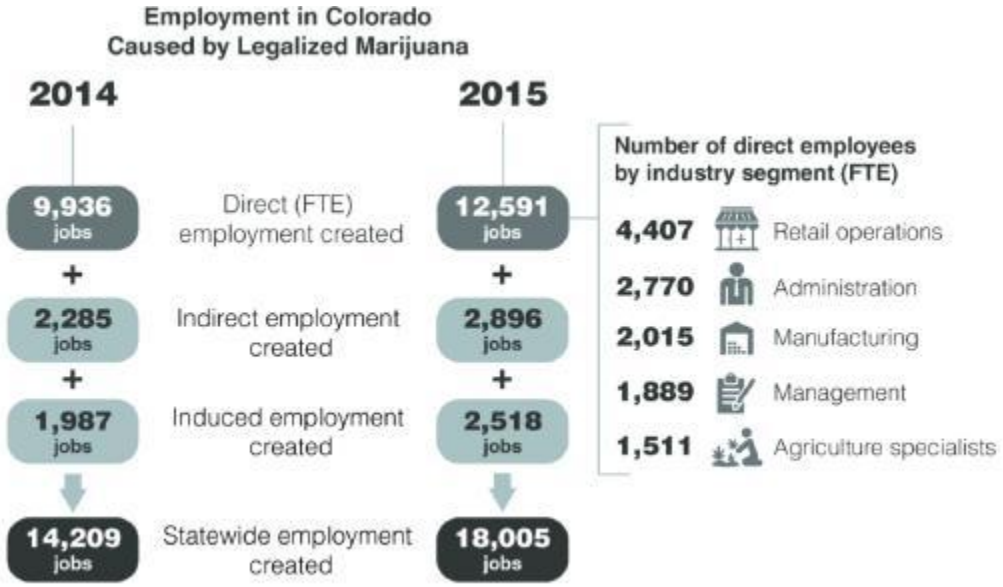
The Marijuana Policy Project (MPP) reported $1.3 billion in legitimate marijuana sales in taxpaying businesses in 2016 rather than black market sales. Approximately $200 million in state tax revenue and license fees came from regulated marijuana sales in 2016, as per data from CDOR. The MPP report states that this number did not include tens of

millions of dollars in local taxes raised by towns and cities throughout the state. The Denver city government reported receiving 29.5 million from local marijuana taxes in 2015, which easily funded the city's costs of education, enforcement, and regulation, estimated at $6.9 million for the year. A July 2016 report by the Legislative Council Staff indicates the legislature distributed close to $220.8 million in marijuana tax funds in fiscal year 2015-16 and 2016-17. Greater than $138.3 million was allocated to the Colorado Department of Education. Prior to the adoption of Amendment 64, Colorado voters were promised that at least $40 million from states taxes would be allocated to the Building Excellent Schools Today (BEST) public school construction program per year. The state tax raised more than $40 million during the 2015-16 fiscal years, which resulted the promised $40 million to the BEST program in FY 2016-17, and additionally $5.7 million to Colorado's Public School Fund. Additional funding went towards increasing the number of health professionals in schools, increasing health related programs in schools, anti-bullying prevention and education, and drop-out prevention programs. (MPP, 2017)

The Marijuana Policy Group (MPG) is a nationally recognized economic and policy consulting firm based in Denver that provides research and analysis on the regulated medical and recreational cannabis market. This information assists government, businesses, and investors in making informed decisions within the regulated cannabis industry. The MPG recently presented the "Marijuana Impact Model", which is promoted as a model that accurately integrates the marijuana industry into Colorado's overall economy. According to the model, 18,005 new full-time jobs were created in 2015 (Figure 19), and total marijuana sales equated to 996 million dollars. (Figure 20)

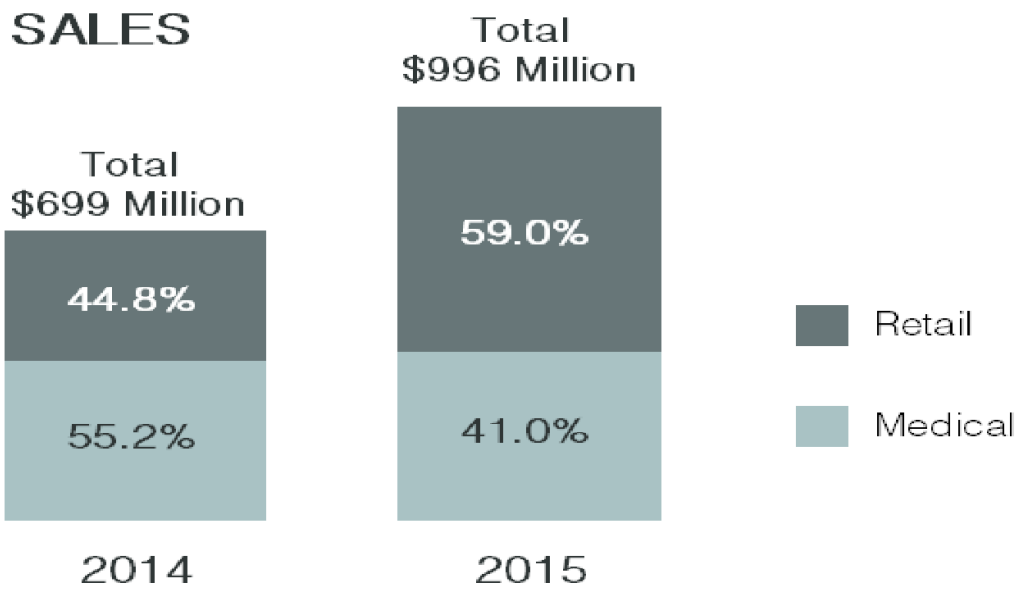
They found that marijuana tax revenue was the second largest excise revenue contributor, and was 14% greater than casinos, and three times higher than alcohol. The MPG predicts marijuana revenue to surpass cigarette revenue by 2020. The MPG also projects an 11.3% growth in marijuana demand per year, till 2020. This growth is attributed to the shift away from the black market, and the increase in marijuana-specific visitors. The regulated market is predicted to become saturated by 2020 leading to a decline in market prices, and peak total sales close to 1.52 billion dollars. (Light, Orens, Rowberry, & Saloga, 2016)

Figure 19: Employment estimates by type in Colorado, 2015



Source: Marijuana Policy Group. **(Light, Orens, Rowberry, & Saloga, 2016)**

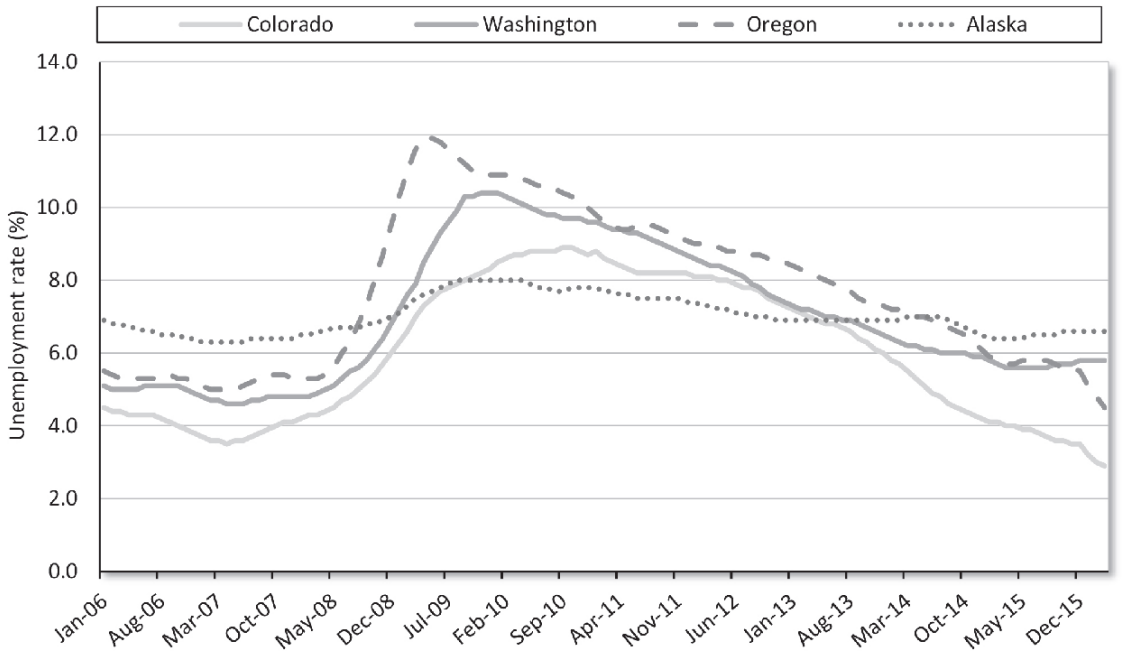
Figure 20: Sales



Source: Marijuana Policy Group. **(Light, Orens, Rowberry, & Saloga, 2016)**

Policy Analysis No. 799, by the CATO institute, also maintains that marijuana commerce and production affected employment rates in Colorado. Statistics from the Bureau of Labor Statistics indicated a dramatic decline in seasonally adjusted unemployment rates in 2014, which correlated with the opening of marijuana stores. The policy analysis found that similar gains were not seen in the other states Alaska, Oregon, and Washington. This difference was attributed to Colorado benefiting from possible '"first mover advantage,"' and as more states legalize marijuana recreationally, employment gains may become more widely spread out and marijuana tourism may decline. (Figure 21) (Dills, et al., 2016)

Figure 21: Unemployment Rates



Source: Bureau of Labor Statistics, Local Area Unemployment Statistics, http://www.bls.gov/lau/.
Note: Rates are seasonally adjusted **(Dills, et al., 2016)**

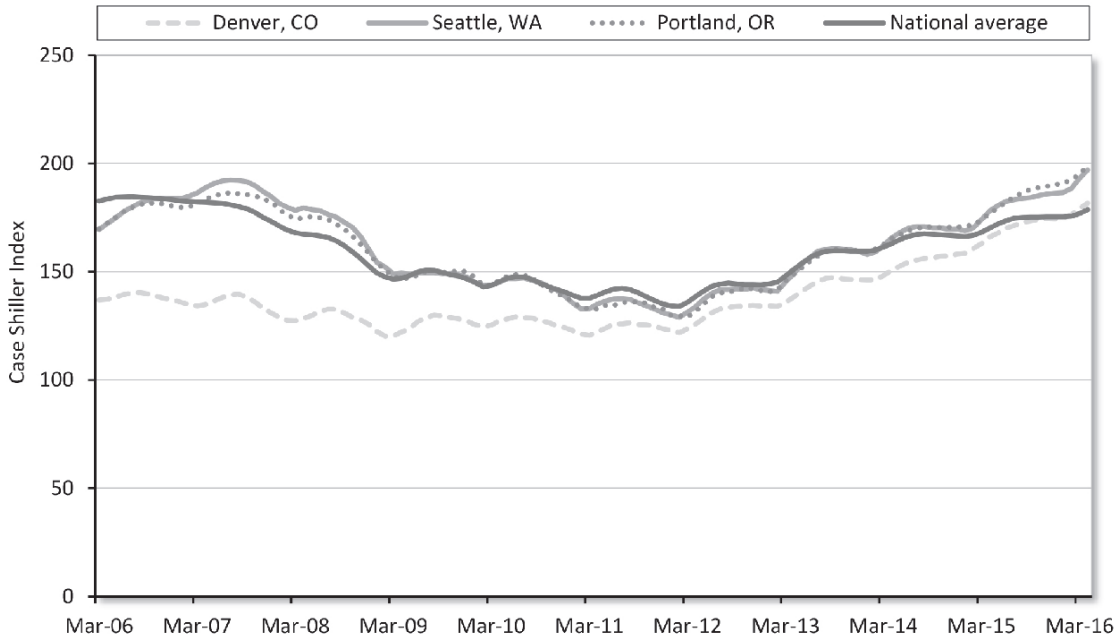
Opponents of Amendment 64 argued that the initiative would affect employer's drug testing policies and create hazardous work environments. However, there have not been any known increases in marijuana related problems in the workplace. After the first year of implementation, there was no increase in loss costs relating to lost wages or medical expenses from on-the-job injuries, and a noted decline in the second year. The Colorado Department of Labor and Employment report no significant rise in amount of lost-time workers compensation claims. According to the Colorado Department of Public Health and Environment (CDPHE), in 2013 and 2014 there were fewer fatal occupational injuries compared to 2011, prior to legalization. According to the Colorado Department of Revenue (CDOR), there are 28,847 individuals with valid occupational licenses to work in the state marijuana businesses as of September 2016. Marijuana businesses also

integrate workers and services related to a wide variety of sectors including construction, real estate, engineering, retail, security, and legal. (MPP, 2017)

According to MPP, the Colorado Tourism Office reports record breaking tourism for the 5th year in a row, and recovery of state's tourism economy is twice that of the national rate. Opponents of the recreational legalization claimed that Colorado's ski and resort industry would be damaged, however, the amount of tourists and dollars spend have reportedly reached all-time highs since 2012. Denver's convention and tourism bureau also report a record high in number of conventions in 2014 that increased by 9% in 2015, while business travel nationwide remained stable. (MPP, 2017)

Data from a housing trend tracker, CoreLogic, reported that Colorado had seen the largest increase in home prices compared to any other state in 2014, and among the fastest increases in 2015. (MPP, 2017) However, Policy Analysis 799 reviewed the Case-Shiller Home Price Index for Denver, Seattle, Portland, and national average, and found that home prices in these cities have been rising since mid-2011, with no significant increases associated with the changes in marijuana policies. (Figure 22) After marijuana shops opened in Denver in January 2014, housing prices did increase at a vigorous rate, but the increase was proportionate to the national average. The policy analysis also concluded that marijuana legalization did not have any significant effects on population growth in any of the four legalizing states. (Dills, et al., 2016)

Figure 22: Case Shiller Home Price Index



Source: S&P Core Logic Case-Shiller Home Price Indices, http://us.spindices.com/index-family/real-estate/sp-corelogic-case-shiller. **(Dills, et al., 2016)**

Summary/Recommendations

Despite the controversy surrounding recreational marijuana use, Amendment 64 has been successfully implemented since its legalization, and continues to develop and improve. In 2014, Colorado began the commercialization of recreational marijuana and established retail marijuana stores. (Blumenauer & Polis, 2014) Colorado was the first to pioneer this legislation and has learned valuable lessons throughout the process. This policy analysis identified the impacts of Amendment 64 on Colorado's marijuana use, risk perception, public health effects, traffic data, crime, and economic impacts.

Marijuana use among adults and adolescent use was a concern of those in opposition of Amendment 64. However, when reviewing the impacts of Amendment 64

on marijuana use, there were no significant statistical changes in daily or past month marijuana use among adolescents or adults in terms of users or frequency since legalization. (RMPHAC, 2017)

The national average of adult marijuana use was 8% compared to 13%, however, data from SAMHSA reveals that Colorado marijuana usage rates have been modestly increasing and have been consistently higher than the national average since prior to 2009, coinciding with the commercialization of medical marijuana. (Dills, Goffard, & Miron, 2016)

Adolescent marijuana use was found to be almost identical to the national average. (RMPHAC, 2017) The Healthy Kids Colorado Survey (HKCS) found that past-month marijuana use in high schoolers was not significantly different between 2013 and 2015 (RMPHAC, 2017), and were nearly identical to the national average reported by the YRBSSS at 22%. Reports have also showed high school marijuana use has fluctuated with no clear trend between 2005-2015. Since 2010, the Colorado high school dropout rates significantly decreased, and graduation rates significantly increased. (MPP, 2017) In regards to the impact of recreational marijuana legalization on pregnancy, the PRAMS survey revealed that marijuana use during pregnancy in Colorado was not found to be statistically different from the national average. (RMPHAC, 2017)

In regards to risk perception, or perceived harmfulness, one article found that youth risk perception in Colorado decreased substantially from 54% in 2014 to 48% in 2015. (Ghosh, et al., 2017) However, studies have found a decrease in risk perception that predates legalization.

The legalization of recreational marijuana in Colorado did have a significant impact on the amount of health outcomes related to emergency department visits and hospitalizations. Between 2013 and 2015, there was a 70% increase in hospitalizations with marijuana related codes, and an increase in ED visits by 19% from 2013 to 2014. The number of ED visits then decreased by 27% to a number lower than in 2013. (RMPHAC, 2017)

Poison center calls also experienced dramatic increases post legalization. Numbers from 2000-2009 were relatively stable, however after commercialization of medical marijuana there was a two-fold increase, followed by another significant increase in 2014. The number of calls has been relatively stable since 2014. These calls accounted for unintentional and intentional marijuana exposures. Children age 0-8 years exhibited the highest increase in unintentional exposures, while adults 25 and over had the highest increase in intentional marijuana exposure calls. (RMPHAC, 2017)

Edibles were found to be a much larger problem than anticipated when marijuana was first legalized recreationally. Strict regulations on edibles were not originally implemented. The edibles were often similar in appearance and taste to their equivalent food product which led to the significant number of unintentional exposures, specifically in the pediatric population. (Wang, 2016)

An article in JAMA evaluated pediatric admissions at Children's Hospital Colorado, Aurora, and regional poison center (RPC) found a higher number of calls for marijuana exposures in children 0-9 between 2009 and 2015. The results found a higher number of RPC cases and hospital visits in the two years prior to legalization and the two

years after. The rate of RPC cases significantly increased at 34% per year in Colorado compared to the U.S. at 19% per year. Around half the pediatric patients seen in the two years after legalization were recreational marijuana exposures which indicated a clear impact of legalization on the incidence of exposures. (Wang, et al., 2016)

Four high profile deaths that occurred after legalization were related to consuming edibles. This prompted significant policy changes in Colorado, particularly in edible safety regulations. Policy efforts implemented included limitations on maximum THC levels per package, stricter packaging, clearly marked serving sizes, universal symbols, and restrictions on packaging that may be appealing to children. (Ghosh, et al., 2017) Other unexpected health concerns were increased prevalence of burns and cyclic vomiting syndrome.

According to the data, the number of DUI cases where marijuana was considered the impairing substance increased in 2014 to 2015 from 12% to 15%. (Reed, 2016) Between 2013 and 2015, the number of driver fatalities that tested positive for marijuana increased by 80%. However, the data did not specify whether the driver was impaired and a full toxicology report was not obtained which identifies limitations to the data. (Ghosh, et al,, 2017)

The MPP reports that the nation as a whole saw an increase in traffic fatalities in 2015 and 2016 and claims the increase was attributed to not wearing seatbelts, “epidemic of distracted driving”, increase in motor cycle accidents, and lower gas prices leading to more miles being driven.

The impact on crime and public safety revealed an 81% decrease in total amount of marijuana-related filings between 2012 and 2015. (Reed, 2016) The Denver County Court process misdemeanors and petty offenses separately from the State Judicial System and found that the amount of marijuana filings remained stable overall. (Reed, 2016) Marijuana industry and non-industry related marijuana crimes have also remained stable from 2012 to 2015. (Reed, 2016) The RMHIDTA reported a 6.2% increase in all crime in Colorado from 2013 to 2015. (Wong, Clarke, & Harlow, 2016)

Diversion of Colorado marijuana to other parts of the country increased 357% in yearly average number of interdiction seizures after the commercialization of medical marijuana, between 2009 and 2012. After recreational legalization, interdiction seizures increased by 37%, and total amount of pounds of Colorado Marijuana seized increased by 30% from 2009-2015. The U.S. Mail has also seen a 427% increase in diversion of Colorado Marijuana by parcel from 2010-2012 and 2013-2015. (Wong, et al., 2016)

In regards to impacts on economy, the Colorado Department of Revenue (CDOR) found an increase of 77% in total revenue from marijuana licenses, taxes, and fees from calendar year 2014 to 2015, $76, 152, 468 to $135, 100, 465. (Reed, 2016) The MPP reported $1.3 billion in legitimate marijuana sale in taxpaying business in 2016 rather than in black market sales. Prior to the adoption of Amendment 64, $40 million in state taxes was promised to be allocated to the Building Excellent Schools Today (BEST) public school construction program. The state raised more than promised and allocated additional funding to the Colorado's Public School Fund. (MPP, 2017)

The Marijuana Policy Group (MPG) reports that 18,005 new, full time jobs were created in 2015 and total marijuana sales generated 996 million dollars. The MPG predicted an 11.3% growth in marijuana demand per year until 2020 when the market becomes saturated, with peak sales close to 1.52 billion dollars. (Light, Orens, Rowberry, & Saloga, 2016)

Overall, the Amendment 64 has had various impacts on Colorado, and the state is constantly working to improve marijuana legislation and strengthen policy efforts. An article published in Preventive Medicine discussed the lessons Colorado has learned and provides recommendations to other states based on their experience thus far. (Ghosh, et al., 2017) When edibles posed a larger threat than anticipated, Colorado strengthened edible safety regulations and the adverse health impacts from edibles began to stabilize.

The Colorado State Patrol (CSP) are researching and improving methods to accurately identify whether marijuana was an impairing substance in DUI's and traffic fatalities. Colorado also faced difficulties validating that laboratories were accurately testing retail marijuana for contaminants and cannabinoid concentrations. The state recommended establishing a reference laboratory and quality testing to ensure reliability between laboratories. Another major state policy decision was to maximize health messaging impacts by investing marijuana tax revenue into social market research. This research educated the state on distinct attitudes about marijuana use among certain populations such as Spanish and English speakers, older and younger populations, and users and nonusers. A campaign called the *Good to Know* campaign was developed from this research. This educated varying audiences on the awareness of marijuana laws, and made almost 170 million media impressions in 9 months. Data revealed that *Good to*

Know had a positive impact, and adults exposed to the campaign had 2.5 times higher knowledge of key laws. (Ghosh, et al., 2017) A study on the *Good to Know* campaign discusses its success and the plan to launch smaller, more focused campaigns to subpopulations including Spanish-speakers, marijuana users, tourists, parents, pregnant and breastfeeding women, adolescents, and health care providers. The study recommends that any state that implements changes in marijuana legislation would benefit from obtaining a baseline awareness of regulations prior to designing public health education campaigns (Brooks-Russell, Levinson, Li, Roppolo, Bull, 2017) Colorado also found that certain surveys such as the Behavioral Risk Factor Surveillance System (BRFSS), PRAMS, and the Child Health Survey (CHS) did not add marijuana related questions until 2013 which made trend analyses difficult. A recommendation was made for states to add marijuana questions to population based surveys before major legislative changes such as marijuana legalization. (Ghosh, et al., 2017)

Another vital lesson learned, was from the alignment of medical and recreational marijuana regulations. Since an advanced medical marijuana system was in place prior to recreational legalization, the state faced unexpected issues that included tax discrepancies, allowable possession amounts, labeling/packaging, and testing requirements. The study recommends that states align regulations proactively in order to avoid uncertainty and confusion. (Ghosh, et al., 2017)

The "Ogden Memo" made laws less strict in terms of federal prosecution, and less punitive to become a medical marijuana "patient." The original commercial markets were already providing to the medical market. When taking this into consideration, the fact that Colorado did not face many drastic changes after full legislation may not seem so

astonishing. States without a tightly regulated system, or advanced medical marijuana legislation in place prior to recreational legalization, may experience entirely different outcomes. (Caulkins, Kilmer, & Kleiman, 2016)

Conclusion

The legalization of recreational marijuana in Colorado has produced various outcomes that Colorado continues to learn and respond to every day. Some studies suggest that it may be too early to assess the public effects of legalization since it is still in its early stages of implementation. However, the state of Colorado has implemented strong surveillance for both health behaviors and outcomes, and has been readily adaptable to healthy policy changes. The impacts of legalization have not revealed any significant changes in marijuana use, risk perception, or crime from prior to legalization. Legalization did lead to an increase in health care visits, traffic outcomes, admissions, and poison center calls. However, Colorado modified policy changes which have alleviated the adverse public health impacts. (Ghosh, et al., 2017) Recreational marijuana legalization increased state tax revenue, in which a large portion went towards public education funds. (Reed, 2016) The MPG predicts the market will peak in 2020 when the market becomes saturated. (Light, Orens, Rowberry, & Saloga, 2016) An increase in jobs, and decrease in employment rates was found after commercialization. Colorado already had an established medical marijuana program in place prior to recreational legalization. States that plan to implement recreational marijuana legislation should take this into consideration, as they may experience different outcomes. (Caulkins, Kilmer, & Kleiman, 2016) States with a legal medical marijuana market that plan to legalize recreational should align laws prior to implementation to avoid confusion. Any states that

are interested in legalization should obtain baseline data on public marijuana use to accurately trend use across all demographics. Colorado also strongly recommended states to obtain baseline public knowledge of the laws in order to launch proper health education campaigns and reduce negative impacts. (Ghosh, et al., 2017)

Colorado mandated the CDPHE to collect data on the impacts of Amendment 64 and the RHMPAC provide recommendations. However, multiple government agencies have also reported and contributed relevant data, which has led to minor inconsistencies in impacts. Colorado, and future states, should consider having a comprehensive impact report from one designated agency, such as the CDPHE. This agency can choose to include data from other organizations, after reviewing and interpreting the data for accuracy and consistency. This would alleviate the variability in data, and provide a precise understanding of the impacts in order for appropriate policy changes to be made if needed.

The environmental impact of recreational marijuana legalization has also been a rising concern. Marijuana plants require twice as much as water as other plants, and have already made an impact in California. Illegal and legal marijuana plantations have been associated with pollution, soil erosion, deforestation, poaching, and wildlife poisoning from pesticides. The water taken from streams and rivers during marijuana growing season has reduced water for agriculture and threatened wildlife species. These impacts should be considered for states that plan to implement recreational marijuana legislation. Possible policy options include providing incentives to farmers that protect natural resources, or implementing strict environmental laws. Environmental impacts should be closely monitored in the growing number of states with recreational marijuana

legislation. Environmental protection laws should be proactively implemented, and these states should include the environmental impacts in their comprehensive reports (Nature Conservancy, 2015)

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Biographical Sketch

This capstone project was completed by Santhi Chilukuri. She is a graduate student from Lemoyne College Physician Assistant Program, Class of 2014. She lives in Brooklyn, NY and is currently a practicing Physician Assistant at Mt. Sinai Hospital Manhattan. She is also pursuing credentials in Health Services Management, upon completion of her Master's degree in Public Health at the University of Kentucky in 2017. Santhi has a passion for improving public health on a small and large scale. She is currently implementing her public health knowledge through practicing as a physician assistant. She later plans to pursue a career in an administrative position at a local health department, office, or hospital where she can have an impact on the public health of a community. She is also a fitness advocate and hopes to become a Zumba instructor and provide free classes to the public. Her long-term goals include organizing medical and health clinics internationally to improve public health in third word and developing countries.

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Appendix A

The HKCS survey and marijuana use in Colorado

The Healthy Kids Colorado Survey (HKCS) collects health information in the fall of odd years from public high school and middle school students. It is a voluntary, anonymous survey, and parents are notified ahead of time. HKCS is a collaboration of the Colorado Department of Public Health and Environment (CDPHE), the Colorado Department of Education, and the Colorado Department of Human Services, who recognized the need to gather critical data while minimizing the student survey requests to Colorado schools. Both state and regional data are available to provide schools and communities with information to support effective strategies to protect the health and promote academic achievement of Colorado youth. This survey also fulfills Colorado's reporting requirement for the CDC sponsored Youth Risk Behavioral Surveillance Survey (YRBS)[1] and ensures Colorado data can be compared to both national data and data from other states. HKCS provides data on a wide range of health issues and risk factors affecting children and youth including: nutrition, physical activity, safety behaviors, mental health, alcohol, tobacco and other substance use, and sexual behaviors (high school only). The survey has included questions on marijuana since 1999.[2] This report includes results from 2005-2015 for high school and 2011-2015 for middle school.

Survey questions

Table 1. Healthy Kids Colorado Survey questions asked of middle school and high school students about whether they use marijuana, when they use it and how they use it, 2005-2015.

Not all questions were included in all years and not all questions were asked of both middle school and high school students.

1. During your life, how many times have you used marijuana?
- 0 times
- 1 or 2 times
- 3 to 9 times
- 10 to 19 times
- 20 to 39 times
- 40 to 99 times
- 100 or more times

2. How old were you when you tried marijuana for the first time?
- I have never tried marijuana
- 8 years old or younger
- 9 or 10 years old
- 11 or 12 years old
- 13 or 14 years old
- 15 or 16 years old
- 17 years old or older

3. During the past 30 days, how many times did you use marijuana?
- 0 times
- 1 or 2 times
- 3 to 9 times
- 10 to 19 times
- 20 to 39 times
- 40 or more times

4. During the past 30 days, how did you use marijuana? (Select all that apply.)
- I did not use marijuana during the past 30 days
- I smoked it
- I ate it (in an edible, candy, tincture or other food)
- I used a vaporizer
- I dabbed it*
- I used it in some other way

5. During the past 30 days, how did you usually use marijuana? (Select only one response.)
- I did not use marijuana during the past 30 days
- I smoked it I ate it (in an edible, candy, tincture or other food)
- I used a vaporizer
- I dabbed it*
- I used it in some other way

*The response option of "I dabbed it" was added in 2015

The National Survey on Drug Use and Health

The Substance Abuse and Mental Health Services Administration (SAMHSA) tracks national and state level data on tobacco, alcohol, marijuana, and illicit drugs including non-medical use of prescription drugs through the National Survey on Drug Use and Health (NSDUH).[3] Colorado past 30 day marijuana use estimates from the NSDUH survey were compared with the Colorado HKCS past 30 day marijuana use estimates

Definitions

Current use – Having used marijuana at least once in the past 30 days (any answer other than '0 times' on question 3))
Dabbing - a method of marijuana use where a "dab" (small amount) of marijuana concentrate is placed on a pre-heated surface, creating concentrated marijuana vapor to be inhaled.
Ever use – having used marijuana at least once in their lifetime (any answer other than '0 times' on question 1)
Tried marijuana before age 13 - answered '11 or 12 years old', '9 or 10 years old', or '8 years old or younger' on question 2
Vaping (vaporization of marijuana) - a method of marijuana use in which marijuana vapor, rather than smoke, is inhaled. Marijuana flower or concentrate is heated in a vaporizing device (vaporizer) to a temperature below the point of combustion, to produce vapor.

How to interpret survey results

Respondents to the Healthy Kids Colorado Survey are a sample of Colorado high school and middle school students. The percent of survey respondents selecting a specific answer might not be exactly the same as if every student in Colorado were surveyed. Therefore, the survey results are estimates, and each has a range of possible values (also called margin of error,

confidence interval, or 95% CI). These ranges are very important when comparing two estimates, and the following terms are used throughout this report:

'Not statistically different'- Typically, if the ranges of possible values *overlap* for two different survey results (like two different years, or male vs. female), we cannot be confident that there is a true difference between the two (also called 'not statistically significant.') In some cases, an additional statistical test is done to confirm.

'Statistically higher' or 'statistically lower'- If the ranges of possible values *do not overlap* for two different results, we CAN be confident that there is a true difference between the two (also called 'statistically significant.')
On the figures in this report, these ranges of possible values are indicated by black bars. In footnotes, they are referred to by the statistical term '95% CI.'

Appendix B

Survey questions

Table 1. Behavioral Risk Factor Surveillance System questions asked of Colorado adults about marijuana use and methods of marijuana use, 2014-2015.

1. Have you ever used marijuana or hashish? (all respondents were asked) 2014/2015

a. Yes
b. No
c. Don't Know/Not Sure

2. How old were you the first time you used marijuana or hashish? (only ever users were asked) 2014/2015

a. Age: _____
b. Don't Know/Not Sure

3. During the past 30 days on how many days did you use marijuana or hashish? (only ever users were asked) 2014/2015

a. Number of Days: _____
b. None
c. Don't Know/Not Sure

4. During the past 30 days, how many times did you drive a car or other vehicle when you had been using marijuana or hashish? (only current users were asked) 2014/2015

a. Number of days _____
b. Don't Know/Not Sure

5. On the days that you did use marijuana, how many times per day did you use it on average? (only current users were asked) 2015

a. Number of times: _____
b. None
c. Don't know/Not sure

6. During the past 30 days, how did you use marijuana? For each of the following methods please say YES if it does apply or NO if it does not apply or Don't know/Not sure. (only current users were asked) 2015

a. Was it vaporized? (e-cigarette-like vaporizer)
b. Was it smoked? (in a joint, bong, pipe, blunt)
c. Was it eaten in food? (in brownies, cakes, cookies, candy)
d. Was it consumed in a beverage? (tea, cola, alcohol)
e. Was it dabbed?
f. Was it used in some other way? _____ (specify)

The National Survey on Drug Use and Health

The Substance Abuse and Mental Health Services Administration (SAMHSA) tracks national and state level data on tobacco, alcohol, marijuana, and illicit drugs including non-medical use of prescription drugs through the National Survey on Drug Use and Health (NSDUH).[3] National and Colorado past 30 day marijuana use estimates from the NSDUH survey were compared with the Colorado BRFSS past 30 day marijuana use estimate (Figure 2).

Definitions

Current use – having used marijuana or hashish on at least one day in the past 30 days (answered at least '1 day in the past 30 days' on question 3) (Table 1)
Dabbing - a method of marijuana use where a "dab" (small amount) of marijuana concentrate is placed on a pre-heated surface, creating concentrated marijuana vapor to be inhaled.
Daily or near daily use - having used marijuana or hashish on twenty to thirty days in the past 30 days (answered '20-30 days in the past 30 days' on question 3) (Table 1)
Ever use – having used marijuana or hashish at least once in their lifetime (answered 'Yes' on question 1) (Table 1)
Monthly use - having used marijuana or hashish on one to three days in the past 30 days (answered '1-3 days in the past 30 days' on question 3) (Table 1)
Vaping (vaporization of marijuana) - a method of marijuana use where marijuana vapor, rather than smoke, is inhaled. Marijuana flower or concentrate is heated in a vaporizing device (vaporizer) to a temperature below the point of combustion, to produce vapor.
Weekly use - having used marijuana or hashish on four to nineteen days in the past 30 days (answered '4-19 days in the past 30 days' on question 3) (Table 1)

How to interpret survey results

Respondents to the BRFSS survey are a sample of Colorado adults. The percent of survey respondents selecting a specific answer might not be exactly the same as if all adults in Colorado were surveyed.
Therefore, the survey results are estimates, and each has a range of possible values (also called margin of error, confidence interval, or 95% CI). These ranges are very important when comparing two estimates, and the following terms are used throughout this report:
'Not statistically different'- Typically, if the ranges of possible values *overlap* for two different survey results (like two different years, or male vs. female), we cannot be confident that there is a true difference between the two (also called 'not statistically significant.') In some cases, an additional statistical test is done to confirm.
'Statistically higher' or 'statistically lower'- If the ranges of possible values *do not overlap* for two different results, we CAN be confident that there is a true difference between the two (also called 'statistically significant.')
On the figures in this report, these ranges of possible values are indicated by black bars. In footnotes, they are referred to by the statistical term '95% CI.'

Appendix C

The PRAMS survey and marijuana use in Colorado

The Pregnancy Risk Assessment Monitoring System (PRAMS) is a survey sponsored by the Centers for Disease Control and Prevention (CDC). The survey asks new mothers questions about their pregnancy and their new baby. It provides data not available from other sources about pregnancy and the first few months after delivery, and allows CDC and the states to monitor changes in maternal and child health indicators, such as unintended pregnancy, prenatal care, breastfeeding, infant health, smoking and alcohol use. These data can be used to identify groups of women and infants at high risk for health problems, to monitor changes in health status, and to measure progress toward goals in improving the health of mothers and infants.[1] In 2014, PRAMS in Colorado asked about marijuana use before, during and after pregnancy

Survey questions

Table 1. Pregnancy Risk Assessment Monitoring System question about marijuana use, 2014.

1. During any of the following time periods, did you use marijuana or hashish (hash)? For each time period, say No if you did not use then or say Yes if you did.

a. During the 3 months before I got pregnant.
b. During the first 3 months of my pregnancy.
c. During the last 3 months of my pregnancy.
d. At any time during my most recent pregnancy.
e. Since my baby was born.
f. Don't know/don't remember

Definitions

Using marijuana during pregnancy was defined by combining three responses: *during the first 3 months of my pregnancy; during the last 3 months of my pregnancy;* and *at any time during my most recent pregnancy*.

Using marijuana and breastfeeding after delivery was defined as answering 'Yes' to using marijuana *since my baby was born* AND answering 'Yes' to one of two breastfeeding questions: *Did you ever breastfeed or pump breastmilk to feed your new baby;* or *Are you currently breastfeeding or feeding pumped milk to your new baby*.

How to interpret survey results

Respondents to the PRAMS survey are a sample of Colorado women who recently gave birth. The percent of survey respondents selecting a specific answer might not be exactly the same as if all Colorado women who recently gave birth were surveyed. Therefore, the survey results are estimates, and each has a range of possible values (also called margin of error, confidence

interval, or 95% CI). These ranges are very important when comparing two estimates, and the following terms are used throughout this report:

'Not statistically different'- Typically, if the ranges of possible values *overlap* for two different survey results (like two different years, or male vs. female), we cannot be confident that there is a true difference between the two (also called 'not statistically significant.') In some cases, an additional statistical test is done to confirm.

'Statistically higher' or 'statistically lower'- If the ranges of possible values *do not overlap* for two different results, we CAN be confident that there is a true difference between the two (also called'statistically significant.')

On the figures in this report, these ranges of possible values are indicated by black bars. In footnotes, they are referred to by the statistical term '95% CI.'

Appendix D

Survey questions

Table 1. Child Health Survey questions about marijuana storage or use in or around the home, 2014-2015.

1. Is there any marijuana or marijuana product in or around your home right now?
Yes
No
2. Where is the marijuana that is currently in or around your home being stored? For each of the following methods please say yes if it does apply or no if it does not apply.
In a childproof container or packaging
In a locked container such as a cabinet, drawer or safe
In a location your child cannot access (such as out of reach)
Someplace else? (specify)
3. During the past 30 days, has anyone- including yourself, used marijuana or hashish inside your home?
Yes
No
4. How was the marijuana that was used inside your home consumed? For each of the following methods please say yes if it does apply or no if it does not apply.
It was vaporized (e-cigarette-like vaporizer)
It was smoked (in a joint, bong, pipe, blunt)
It was eaten in food (in brownies, cakes, cookies, candy)
It was consumed in a beverage (tea, cola, alcohol)
It was used in some other way (specify)
It was dabbed *(response option was added in 2015)*

Definitions

Dabbing – a method of marijuana use where a "dab" (small amount) of marijuana concentrate is placed on a pre-heated surface, creating concentrated marijuana vapor to be inhaled.
Possible exposure to second-hand marijuana smoke or vapor within the home - defined by combining three responses from question 4: *it was vaporized; it was smoked;* and *it was dabbed*. Dabbing was added as a response in 2015; therefore, this category could be underrepresented in 2014 because respondents who dabbed within the home may have indicated *it was used in some other way*.
Safe storage of marijuana - defined by combining three responses from question 2: *in a childproof container or packaging*; *in a locked container such as a cabinet, drawer, or safe;* and *in a location your child cannot access*. The response *someplace else* was considered potentially unsafe storage and a risk for unintentional ingestion.
Vaping (vaporization of marijuana) - a method of marijuana use where marijuana vapor, rather than smoke, is inhaled. Marijuana flower or concentrate is heated in a vaporizing device (vaporizer) to a temperature below the point of combustion, to produce vapor.

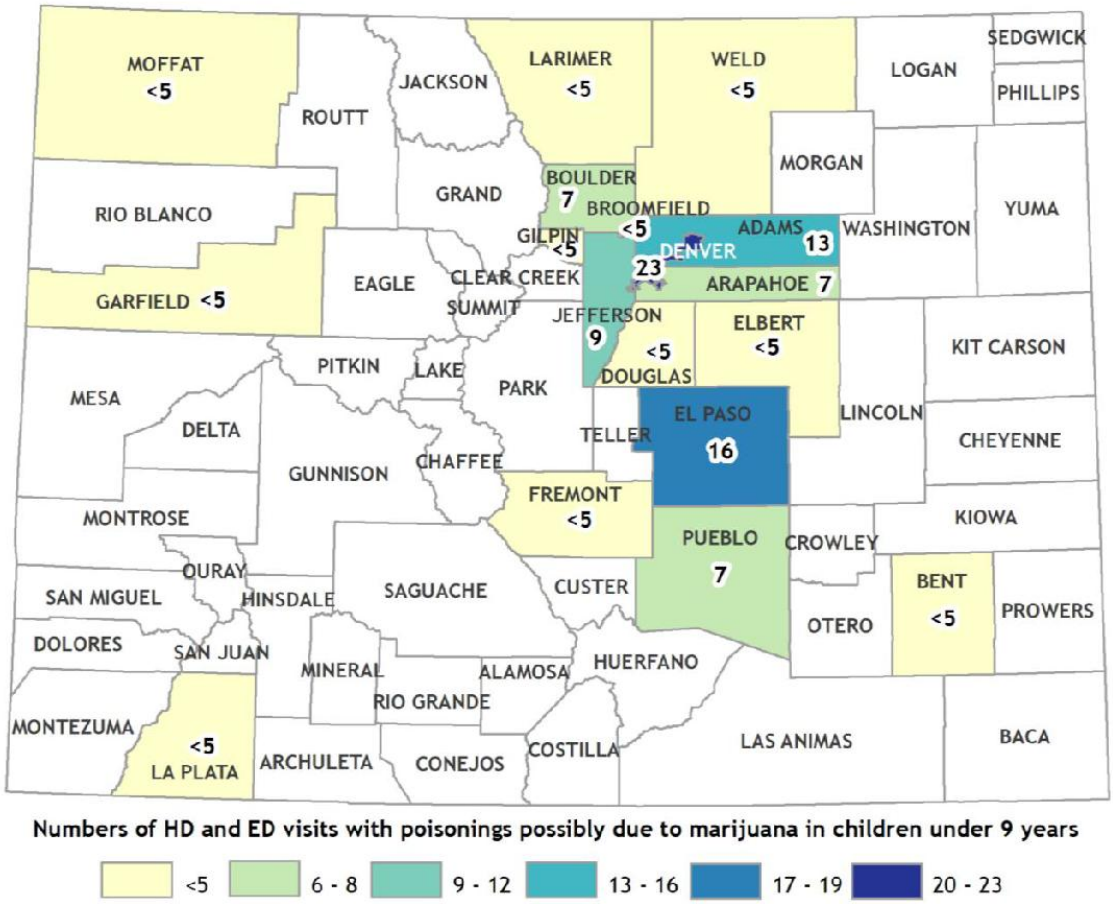
How to interpret survey results

Respondents to the Child Health Survey are a sample of Colorado adults with children 1-14 years old. The percent of survey respondents selecting a specific answer might not be exactly the same as if all adults with children 1-14 years old in Colorado were surveyed. Therefore, the survey results are estimates, and each has a range of possible values (also called margin of error, confidence interval, or 95% CI). These ranges are very important when comparing two estimates, and the following terms are used throughout this report:

'Not statistically different'- Typically, if the ranges of possible values *overlap* for two different survey results (like two different years, or male vs. female), we cannot be confident that there is a true difference between the two (also called 'not statistically significant.') In some cases, an additional statistical test is done to confirm.
'Statistically higher' or 'statistically lower'- If the ranges of possible values *do not overlap* for two different results, we CAN be confident that there is a true difference between the two (also called 'statistically significant.')
On the figures in this report, these ranges of possible values are indicated by black bars. In footnotes,they are referred to by the statistical term '95% CI.'

Appendix E

Map 1. Numbers of hospitalizations (HD) and emergency department (ED) Visits with poisonings possibly due to marijuana in children Under 9 Years of age in Colorado, 2004-2014 by county



Produced by: EEOHT, CDPHE 2016
*Counties shown in white have no reported HD or ED visits with poisonings possibly due to marijuana in children under 9 years.
†ICD-9-CM codes 969.6 and E854.1 were used to determine HD and ED visits with poisonings possibly due to marijuana.
‡Data source: Colorado Hospital Association (CHA). **(RMPHAC, 2017)**