



# Monitoring Health Concerns Related to Marijuana in Colorado: 2018

## Summary

Detailed findings and data available at [colorado.gov/marijuanahealthinfo](https://colorado.gov/marijuanahealthinfo)

# About this summary

This report was prepared by the Marijuana Health Monitoring and Research Program at the Colorado Department of Public Health and Environment on behalf of the Retail Marijuana Public Health Advisory Committee. The complete report, including all data and literature review findings, is now presented as a website:

[www.colorado.gov/marijuanahealthinfo](http://www.colorado.gov/marijuanahealthinfo)

This change of format compared to previous years allows more timely updates and ensures that readers can access the most accurate information. This format also improves the available data visualizations and allows readers to interactively query the data to their specific interest.

The report website and this 2018 summary are provided to the Colorado State Board of Health, the Colorado Department of Revenue, and the Colorado General Assembly by the Retail Marijuana Public Health Advisory Committee pursuant to:

## **25-1.5-110, C.R.S. Monitor health effects of marijuana**

“The department shall monitor changes in drug use patterns, broken down by county or region, as determined by the department, and race and ethnicity, and the emerging science and medical information relevant to the health effects associated with marijuana use. The department shall appoint a panel of health care professionals with expertise in cannabinoid physiology to monitor the relevant information. The panel shall provide a report by January 31, 2015, and every two years thereafter to the state Board of Health, the Department of Revenue, and the General Assembly. The department shall make the report available on its web site. The panel shall establish criteria for studies to be reviewed, reviewing studies and other data, and making recommendations, as appropriate, for policies intended to protect consumers of marijuana or marijuana products and the general public. The department may 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.”

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# Introduction

## Background

When Colorado became one of the first two states in the nation to legalize retail marijuana, the Colorado Legislature mandated that the Colorado Department of Public Health and Environment (CDPHE) study the potential public health effects of marijuana. Though medical marijuana has been legal in Colorado since 2000, it was largely viewed as an individual doctor/patient decision outside the scope of public health policy. However, the legalization of retail (non-medical) marijuana and the potential for greater availability of marijuana in the community prompted a closer look at potential health effects on the population at large.

Legalized retail marijuana presents a paradigm shift, grouping marijuana with other legal substances like alcohol, tobacco and prescription drugs, as opposed to illicit drugs like cocaine and heroin. As with alcohol, tobacco and prescription drugs, misuse of marijuana can have serious health consequences. The standard public health approaches to alcohol, tobacco and prescription drugs are to monitor use patterns and behaviors, health care use, potential health effects, and emerging scientific literature to guide the development of policies or consumer education strategies to prevent serious health consequences. This report summary presents information on the major findings of marijuana use patterns, potential health effects and the most recent scientific findings associated with marijuana use, with a key objective of helping facilitate evidence-based policy decisions and science-based public education campaigns.

In 25-1.5-110, C.R.S., the Colorado Department of Public Health and Environment (CDPHE) was given statutory responsibility to:

“... monitor changes in drug use patterns, broken down by county or region, as determined by the department, 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.”

# Section 1: Monitoring Changes in Marijuana Use Patterns

## Background

The Colorado Department of Public Health and Environment (CDPHE) was given statutory responsibility (in 25-1.5-110, C.R.S.) 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.”

Patterns of drug use are typically determined by using population-based surveys that ask specific questions about substance use. Colorado has several population-based surveys to assess the prevalence of a variety of health conditions and behaviors of specific populations. In addition, there are national population-based surveys that collect state level data on marijuana use. The data from these surveys are compiled here to meet the reporting requirements set forth in 25-1.5-110, C.R.S. Reviewing marijuana use patterns in Colorado provides important insight to the committee members as they consider public health recommendations.

## Data sources

### Adult use: Behavioral Risk Factor Surveillance System (BRFSS)

The Behavioral Risk Factor Surveillance System (BRFSS) is a telephone survey of adults ages 18 years and older, sponsored by the U.S. Centers for Disease Control and Prevention (CDC). It is the nation’s premier system of health-related telephone surveys that collect data from U.S. residents regarding their health-related risk behaviors, chronic health conditions and safety practices. CDPHE, in a cooperative agreement with CDC, manages and administers BRFSS annually in Colorado. Beginning in 2014, Colorado added questions about marijuana use to the state-level BRFSS and has continued to include them in subsequent years.

### Marijuana in homes with children: Child Health Survey (CHS)

The Child Health Survey (CHS) is a telephone survey conducted among respondents to the BRFSS Survey who have children ages 1-14 in their home. Adult respondents answer questions about their children and the home environment. This annual survey provides data on a wide range of health issues and risk factors affecting children and youth in Colorado. Since 2014, questions about marijuana use and storage in the home have been included in the survey.

### Adolescent and young adult use: Healthy Kids Colorado Survey (HKCS)

The Healthy Kids Colorado Survey (HKCS) collects health information from public high school and middle school students. It is a voluntary, anonymous survey, completed by students individually in their classrooms, and parents are notified ahead of time. HKCS is a collaboration of CDPHE, the Colorado Department of Education, and the

Colorado Department of Human Services. This survey is conducted every odd-year and includes questions from the national Youth Risk Behavior Surveillance System (YRBSS). HKCS has included questions on marijuana since 1999.

### Adolescent and adult use: National Survey on Drug Use and Health (NSDUH)

The Substance Abuse and Mental Health Services Administration (SAMHSA) tracks national and state level data on tobacco, alcohol, marijuana, and illicit drug use through the National Survey on Drug Use and Health (NSDUH). This annual survey is completed by an in-person interview at the respondent's home, and includes one or two residents who are at least 12 years old. NSDUH is the only data source that estimated past 30 day marijuana use among adults prior to legalization in Colorado. Although the survey design differs and is not the ideal comparison to BRFSS and HKCS, it can be used as an indicator for state and national marijuana use estimates. Marijuana use estimates are included in this report for comparison purposes.

### Use during pregnancy: Pregnancy Risk Assessment Monitoring System (PRAMS)

The Pregnancy Risk Assessment Monitoring System (PRAMS) is an annual survey of women who recently gave birth. It is sponsored by the Centers for Disease Control and Prevention (CDC) and administered by CDPHE in Colorado on an annual basis. PRAMS provides data about maternal and child health indicators, such as unintended pregnancy, prenatal care, breastfeeding, infant health, smoking and alcohol use during pregnancy and the first few months after delivery. In 2014, Colorado added questions about marijuana use before, during, and after pregnancy to the state-level PRAMS.

### Adolescent and young adult use: Youth Risk Behavior Surveillance System (YRBSS)

The Youth Risk Behavior Surveillance System is the national biennial survey of high school students sponsored by the Centers for Disease Control (CDC). YRBSS is an in-school survey administered by health and/or education agencies in every state and is representative of students attending high school grades 9-12 in the U.S. In Colorado, YRBSS questions are included in the Healthy Kids Colorado Survey (HKCS) and can therefore be directly compared.

## Limitations

These surveys rely on self-reported information, so there is no way to confirm whether each respondent has answered truthfully. These types of surveys have been validated in various studies, which indicate most people do answer truthfully. Consistency in methodology from year to year for each of the surveys provides confidence that trends over time can be effectively monitored.

## Key details about all five surveys

Survey	Population and ages studied	Years	Data collection method
BRFSS	Adults age 18 and up	2014-2017	Telephone survey
CHS	Parents of children age 1-14	2014-2017	Telephone survey
HKCS	Middle and high school students in 6th-12th grades	1999-2017	In-school paper survey
YRBSS	High school students in 9th-12th grades	1991-2017	In-school survey
NSDUH	Adolescents and adults age 12 and up	1971-2016	In-person, at home survey
PRAMS	Recently pregnant women	2014-2016	Mailed paper and telephone survey

## Summary of key findings

This section highlights prominent findings from all surveys capturing marijuana use in Colorado. All findings and detailed results of the surveys can be found at: [www.colorado.gov/marijuanahealthinfo](http://www.colorado.gov/marijuanahealthinfo).

### Trends in adult marijuana use in Colorado

#### Increasing prevalence of marijuana use among adults

In 2017, marijuana use in the past 30 days among adults 18 years and older significantly increased to 15.5 percent from 13.6 percent in 2016. The NSDUH estimated Colorado past 30 day marijuana use at 17.2 percent, which was higher than the BRFSS estimate (15.5 percent) but not statistically different (Figure 1). The NSDUH did not show a statistical change from 2016 to 2017 in Colorado past 30 day adult marijuana use. National past 30 day adult marijuana use was 9.5 percent and significantly increased from 2016 to 2017. Both BRFSS and NSDUH estimate adult marijuana use in Colorado to be significantly higher than the national average.

Similar to prior years, young adults aged 18-25 years reported the highest prevalence of marijuana use in the past 30 days (29.2 percent) in 2017 compared to other age groups. Use among adults aged 26-34 years significantly increased from 19.4 percent in 2016 to 26.4 percent in 2017, as did use among adults aged 65+, increasing from

4.2 percent in 2016 to 5.6 percent in 2017. Adult past 30 day marijuana use remained significantly higher in men (19.8 percent) than in women (11.2 percent) in 2017. In 2017 adult male past 30 day marijuana use (19.8 percent) significantly increased compared to 2016 (16.4 percent). Adults who reported identifying as gay, lesbian, bisexual or other sexual orientation (34.7 percent) had significantly higher past 30 day marijuana use than those identifying as heterosexual (14.5 percent).

### Increasing frequency of use among adult marijuana users

Adult daily or near daily marijuana use also increased significantly from 6.4 percent in 2016 to 7.6 percent in 2017. Adult marijuana daily or near daily use (7.6 percent) remained statistically lower than daily or near daily tobacco use (14.6 percent) and past 30 day binge drinking (18.9 percent) in 2017 (Figure 2). In 2017 adult male daily or near daily marijuana use (10.3 percent) significantly increased compared to 2016 (7.9 percent). Adult daily or near daily marijuana use remained constant from 2016 to 2017 in all Colorado regions except for Denver-Boulder region which significantly increased from 5.8 percent in 2016 to 8.3 percent in 2017, making it the region with the highest daily or near daily marijuana use prevalence in the Colorado.

### Changes in the methods of use for adult marijuana users

In 2017, 50 percent of adult past 30 day marijuana users reported multiple methods of marijuana use, which was significantly higher than 2016 (43.1 percent) (Figure 3). The majority of adult past 30 day users reported smoking marijuana (84.3 percent) followed by eating or drinking (40.4 percent), vaporizing (29.1 percent), dabbing (21.1 percent), and/or using some other method (7.5 percent). Respondents could report using more than one method. Past 30 day use by dabbing, vaporizing, and/or eating or drinking marijuana increased significantly from 2016 to 2017.

### No changes in driving behavior among adult marijuana users

In 2017, 3.0 percent of adults in Colorado reported driving a vehicle within a few hours after using marijuana. There was no statistical change from 2014 to 2017.

## Trends in adolescent marijuana use in Colorado

### Marijuana use among adolescents stable since 2005

In 2017, HKCS estimated 19.4 percent of Colorado high school students and 5.2 percent of middle school students reported using marijuana in the past 30 days. This is not statistically different from 2015 (21.2 percent and 4.4 percent) and past 30 day marijuana use has remained stable among high school students since 2005 and among middle school students since 2011. When comparing marijuana use in Colorado high school students to high school students nationally, YRBSS is the preferred survey for this comparison since it and HKCS both include the same questions and use the same survey methodology and administration. HKCS 2017 estimates of past 30 day marijuana use (19.4 percent) and ever marijuana use (35.2 percent) in Colorado high school students are not

statistically different than the YRBSS national estimates of past 30 day use (19.8 percent) and ever use (35.6 percent) in high school students (Figure 4).

2017 was the first time high school females (19.7 percent) showed higher past 30 day marijuana use than males (18.9 percent), though this difference is not statistically significant. Prevalence of current marijuana use continues to increase with grade level. The highest prevalence is in high school seniors with 25.7 percent reporting marijuana use in the past 30 days. Similar to use trends among adults, students identifying as gay, lesbian, or bisexual reported significantly higher past 30 day use (30.9 percent) than those identifying as heterosexual (18.2 percent). Past 30 day marijuana use among high school students identifying as gay, lesbian, or bisexual significantly decreased in 2017 (30.9 percent) from 2013 (39.7 percent). Past 30 day marijuana use among high school students was highest in Native Hawaiian/ Pacific Islander students (23.1 percent) and students of multiple or other races (27.1 percent).

### Frequency of use has declined or remained stable among adolescents

HKCS 2017 estimated 4.7 percent of high school students reported using marijuana daily or near daily (20 or more times in the past 30 days). The percentage of high school students who reported using marijuana one to nine times in the past 30 days has remained stable since 2005. High school students who reported using 10 or more times in the past 30 days has declined since 2005. Specifically, high school students who reported using 40 or more times in the past 30 days peaked in 2009 at 6 percent and decreased to 3 percent in 2017.

### No changes in the age of first-use among high school seniors

In 2017, the majority of high school seniors who ever used marijuana said they first used it at ages 15-16 (44.8 percent) with 82.1 percent first using marijuana at or before age 16. This trend has remained stable since 2013. In 2017, 8.6 percent of Colorado middle school students had ever used marijuana and 5.2 percent used within the past 30 days. These trends have remained stable since 2011.

### Marijuana use higher than smoking cigarettes, but less than alcohol use and nicotine vaping among high school students

When comparing marijuana to other substance use, HKCS 2017 estimated high school students' past 30 day use of alcohol (28.7 percent) and electronic vapor product with nicotine (27.0 percent) was significantly higher than marijuana use, but marijuana use (19.4 percent) was significantly higher than reported smoking tobacco cigarettes (7.2 percent) and prescription drug use (5.1 percent) (Figure 5).

### Significant increases in dabbing and edible use among high school students

Among the 19.4 percent of high school students who used marijuana in the past 30 days, 88.4 percent reported smoking marijuana in 2017, which was significantly lower than 2015 (91.6 percent). Past 30 day edible use increased significantly from 27.8 percent in 2015 to 35.6 percent in 2017. There were no changes in dabbing (34.4 percent), vaporizing (20.3 percent), or using marijuana in some other way (7.3 percent) in 2017 compared to 2015. High school students who used marijuana in the past 30 days were also asked about their

usual method of marijuana use. The majority (77.8 percent) reported smoking as the usual use method; however, significant increases in dabbing (7.6 percent) or eating (9.8 percent) as usual method of use were reported in 2017 compared to 2015 (4.3 percent and 2.1 percent respectively) (Figure 6).

### No changes in marijuana-related driving/riding behaviors among high school students

In 2017, 29.0 percent of high school students reported riding one or more times in a vehicle driven by someone who had been using marijuana and/or drove one or more times when they had been using marijuana. Although lower than the 2015 estimate, this estimate has not significantly changed since 2011 (24.8 percent) (Figure 7).

## Marijuana in Colorado homes with children

### Increasing number of homes with children where marijuana is stored

In 2017 the CHS estimated 11.2 percent of homes with children reported marijuana being present in or around the home, which was a significant increase from 2014 (6.9 percent) (Figure 8). Among those homes, the majority (77.6 percent) reported storing marijuana safely by keeping it in child-resistant packaging, out of reach, or in a locked location. In 2017 it is estimated that 23,009 homes in Colorado with children aged 1-14 years had marijuana in the home and potentially unsafely stored.

### Continued concern about secondhand exposure among children

In 2017, 5.5 percent of homes in Colorado with children reported marijuana being used inside the home (Figure 9). To estimate how marijuana was being used inside the home, CDPHE combined CHS data for 2016 and 2017 to yield an estimated average of 4.3 percent of homes with children reported marijuana being used in the home. Among those homes, 83.1 percent of homes reported marijuana being smoked, vaporized, and/or dabbed in the home, and 33 percent reported marijuana edibles being used in the home. The 2016-2017 estimate indicates approximately 32,800 homes with children 1-14 years old had possible secondhand marijuana smoke or vapor exposures. These estimates are inclusive of one or more methods of marijuana use in the home.

## Trends in marijuana use during pregnancy and breastfeeding in Colorado

### Increasing concern about marijuana use during pregnancy and breastfeeding

In 2016 the PRAMS estimated 15.2 percent of new mothers used marijuana during the three months before pregnancy, 7.8 percent used at any time during their pregnancy, and 4.4 percent used postpartum and were still breastfeeding at the time the survey was completed (Figure 10). These estimates have remained stable since data were first collected in 2014. The trend of marijuana use decreasing from before pregnancy to during pregnancy, and from during pregnancy to postpartum also remains stable over time. This was significantly less than alcohol use before (65.9 percent) and during (17.3 percent) pregnancy, but not different from tobacco use before (14.7 percent) and during (6.4 percent) pregnancy.

## Increased marijuana use among younger moms and those with unintended pregnancies

Data combined from 2014-2016 showed marijuana use during pregnancy was significantly higher in younger moms aged 15-19 years old (13.3 percent) compared to moms aged 20-24 years old (12.3 percent), 25-34 years old (5.3 percent), and moms 35 years old or older (3.4 percent). Marijuana use during pregnancy was significantly higher among moms with less than 12 years of education (10.6 percent) compared to moms with more than 12 years of education (4.8 percent). Marijuana use during pregnancy was significantly higher among women who did not intend to become pregnant (10.4 percent) compared to women who intended to become pregnant (4.1 percent).

## Discussion

Marijuana use in Colorado is more complex than any one population-based survey can capture. Currently available data cannot answer all the important questions we have about whether or not marijuana use patterns are changing as a result of legalization. Furthermore, it is too early to determine if documented trends will persist in years to come. The data presented here provide important insights into marijuana use in adults, as well as the disparities among vulnerable populations such as pregnant women and youth.

## Encouraging trends

- Since the 2016 report we have not identified any new disparities in adult marijuana use by age, gender, race, ethnicity or sexual orientation since legalization.
- Daily or near daily marijuana use among adults is much lower than binge drinking and daily or near daily tobacco use.
- For adolescents, estimated prevalence of past 30 day marijuana use and frequencies of marijuana use have not changed since legalization.
- Past 30 day marijuana use among Colorado adolescents is similar to the national average.
- Among adolescents, past 30 day marijuana use continues to be lower than past 30 day alcohol use and electronic vapor products with nicotine use.
- The majority of homes in Colorado with children do not have marijuana present or being used inside the home. Among homes that do have marijuana present, the majority of homes are storing marijuana safely.

## Trends to continue monitoring

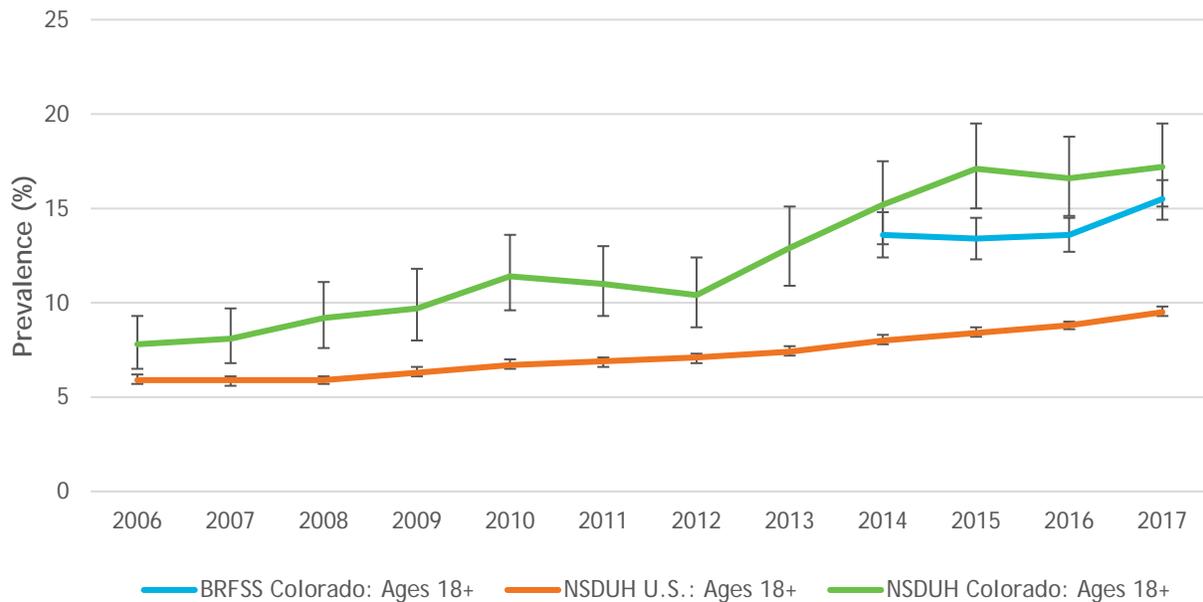
- Past 30 day marijuana use (15.5 percent) and daily or near daily (7.6 percent) use among adults in Colorado has increased in 2017.
- Past 30 day marijuana use among adults in Colorado is higher than the national average. In Colorado, 29.2 percent of adults ages 18-25 reported use in the past 30 days and 15.4 percent reported daily or near daily marijuana use.
- Half of adult marijuana users in Colorado consume marijuana using more than one method. Past 30 day use by dabbing (21.1 percent), vaporizing (29.1 percent), and/or eating or drinking (40.4 percent) marijuana increased from 2016 to 2017.

- There continue to be disparities in marijuana use based on age, sex, race/ethnicity, and sexual orientation for both adults and adolescents, signifying health inequities in certain populations in Colorado.
- Since 2014, use among adults and adolescents has remained consistently higher in the Southwest region of the state.
- 4.7 percent of high school students used marijuana 20 or more times in the past 30 day. This percentage has remained stable since 2005.
- Almost half of high school seniors first used marijuana when they were 15 or 16 years old. 82.1 percent of the high school seniors who reported ever using marijuana first tried it by age 16. This supports prevention efforts focusing on adolescents before they enter high school.
- At least 23,009 homes with children in Colorado may not be storing marijuana products safely, which increases the risk of accidental ingestion of marijuana products by others, in particular children.
- At least 32,800 Colorado children are estimated to be at risk of exposure to secondhand marijuana smoke in the home.
- 7.8 percent of pregnant women use marijuana during pregnancy. This percentage is higher among those with unintended pregnancies, younger mothers, and mothers with less education.

## Recommendations and future directions

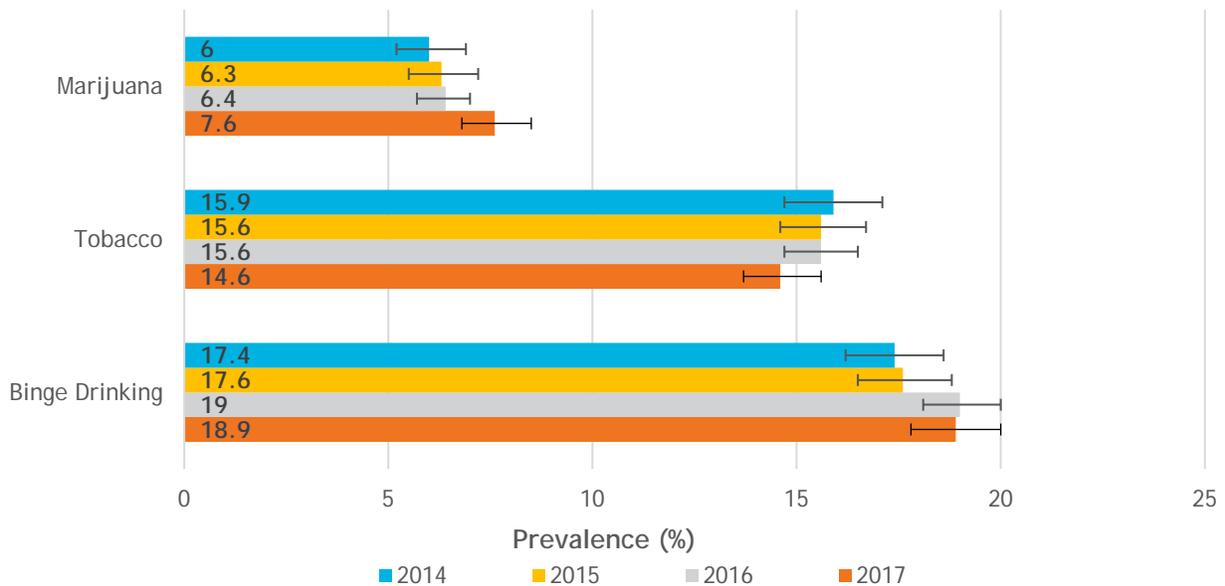
1. Continue assessing prevalence of marijuana use via large Colorado-based surveys including the Pregnancy Risk Assessment Monitoring System, Healthy Kids Colorado Survey, Behavioral Risk Factor Surveillance System and the Child Health Survey. Data from surveys identify trends in use patterns that can be used to inform and target education and prevention strategies. Continued surveys using the same methodology can act as a feedback loop to ensure marijuana policies and education campaigns are effective.
2. Continue to develop, improve and explore additional data sources to monitor marijuana use patterns.
3. Continue in-depth analyses of existing survey data to assess risk and protective factors for marijuana use, including changes in the perception of harm from marijuana use.
4. Continue collaboration with other state and national agencies to identify data that might add additional detail about use patterns in specific populations or geographic areas in the state.

Figure 1: Past 30 day marijuana use among adults in Colorado and the U.S., 2006-2017.



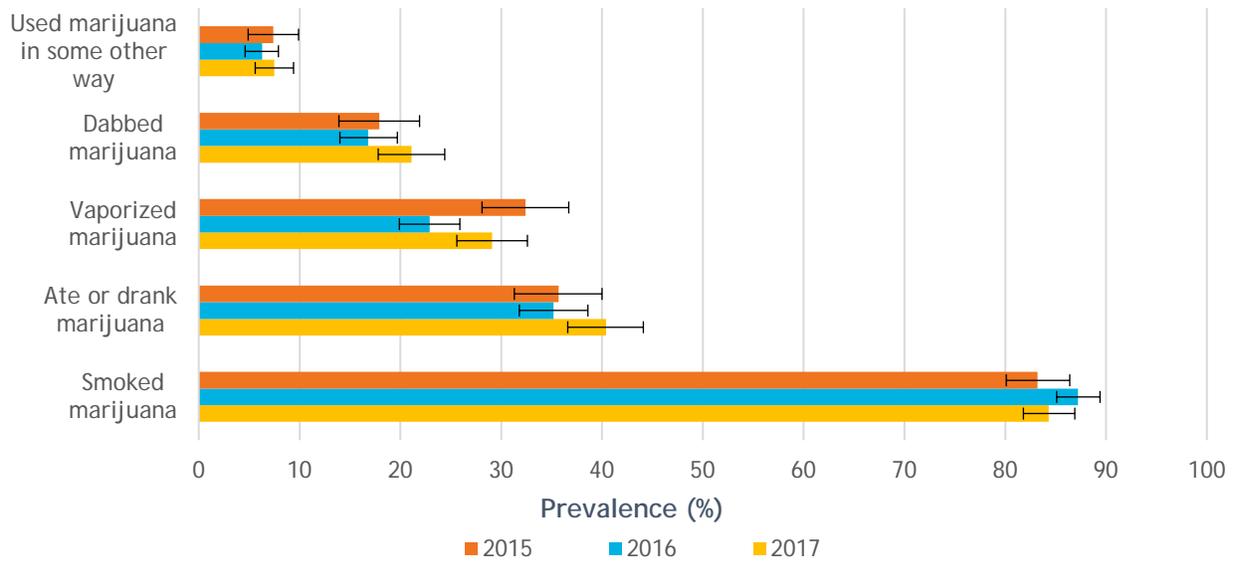
Produced by: Marijuana Health Monitoring Program, Colorado Department of Public Health & Environment 2018.  
 Data Sources: Behavioral Risk Factor Surveillance System (BRFSS); National Survey on Drug Use and Health (NSDUH).  
 \*Black bars indicate margins of error (95% Confidence Intervals).

Figure 2: Daily or near daily marijuana use compared to daily or near daily tobacco use and past 30 day binge drinking among Colorado adults, 2014-2017.



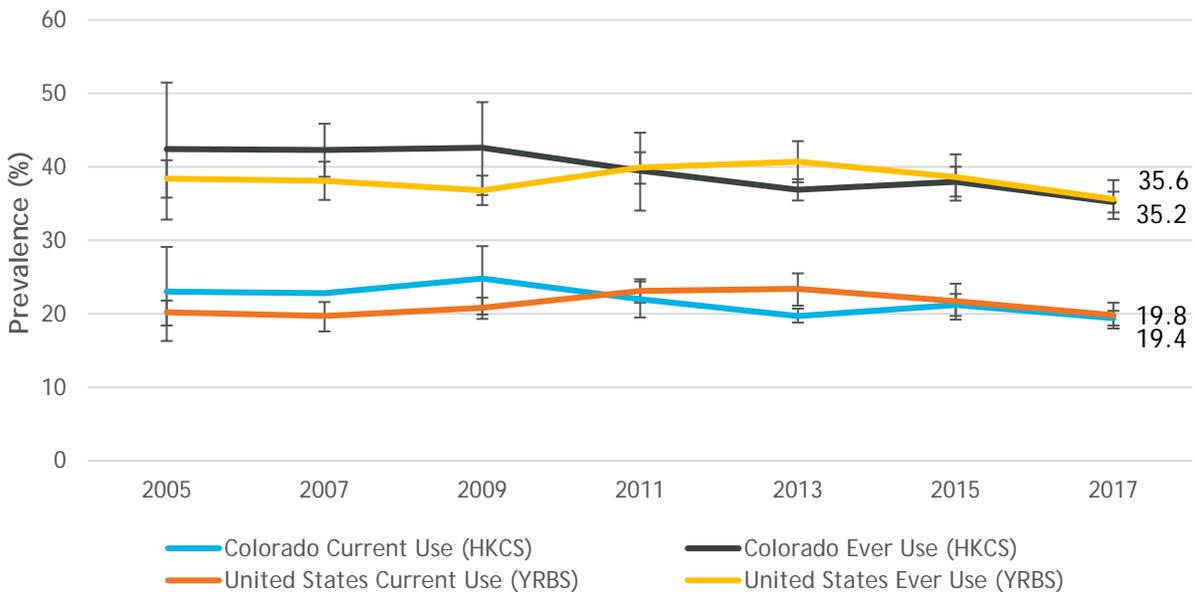
Produced by: Marijuana Health Monitoring Program, Colorado Department of Public Health & Environment 2018.  
 Data Sources: Behavioral Risk Factor Surveillance System (BRFSS).  
 \*Black bars indicate margins of error (95% Confidence Intervals).

Figure 3: Methods of marijuana use among Colorado adults, 2015-2017.



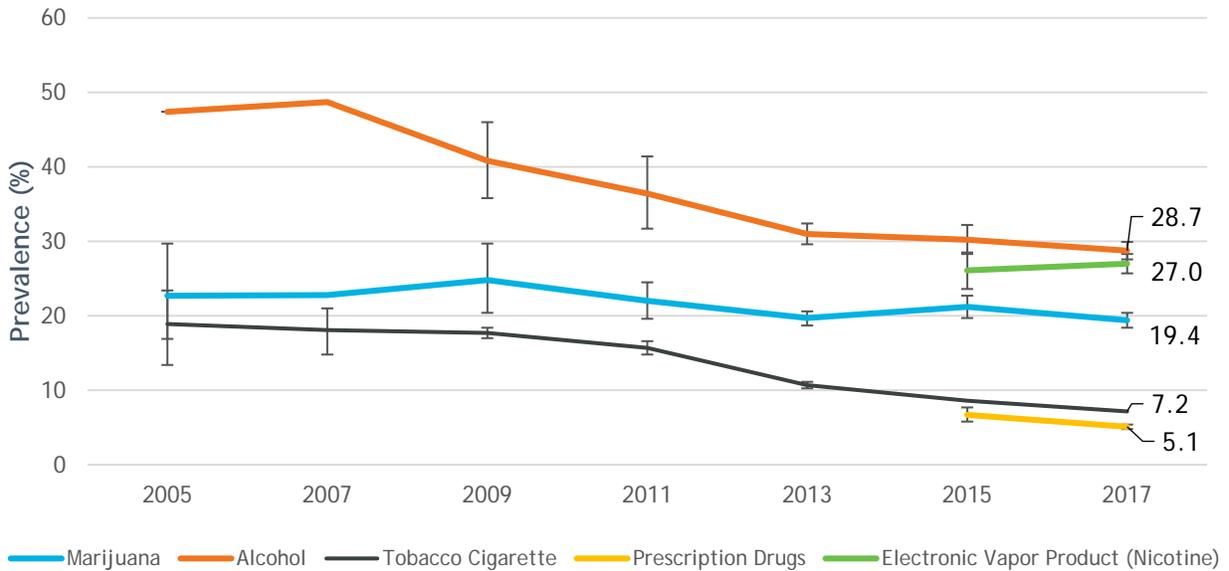
Produced by: Marijuana Health Monitoring Program, Colorado Department of Public Health & Environment 2018.  
 Data Sources: Behavioral Risk Factor Surveillance System (BRFSS).  
 \*Black bars indicate margins of error (95% Confidence Intervals).

Figure 4: Marijuana use among high school students in Colorado and the U.S., 2005-2017.



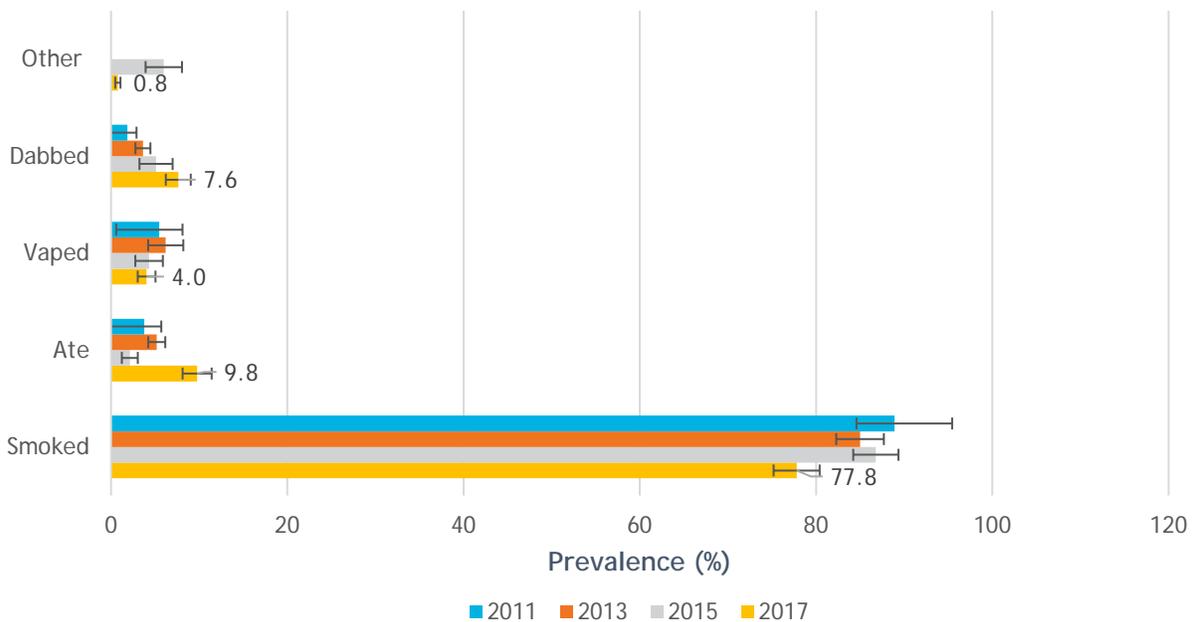
Produced by: Marijuana Health Monitoring Program, Colorado Department of Public Health & Environment 2018.  
 Data Sources: Healthy Kids Colorado Survey (HKCS), Youth Risk Behavior Surveillance System (YRBS).  
 \*Black bars indicate margins of error (95% Confidence Intervals).

Figure 5: Prevalence of past 30 day substance use among high school students in Colorado, 2005-2017.



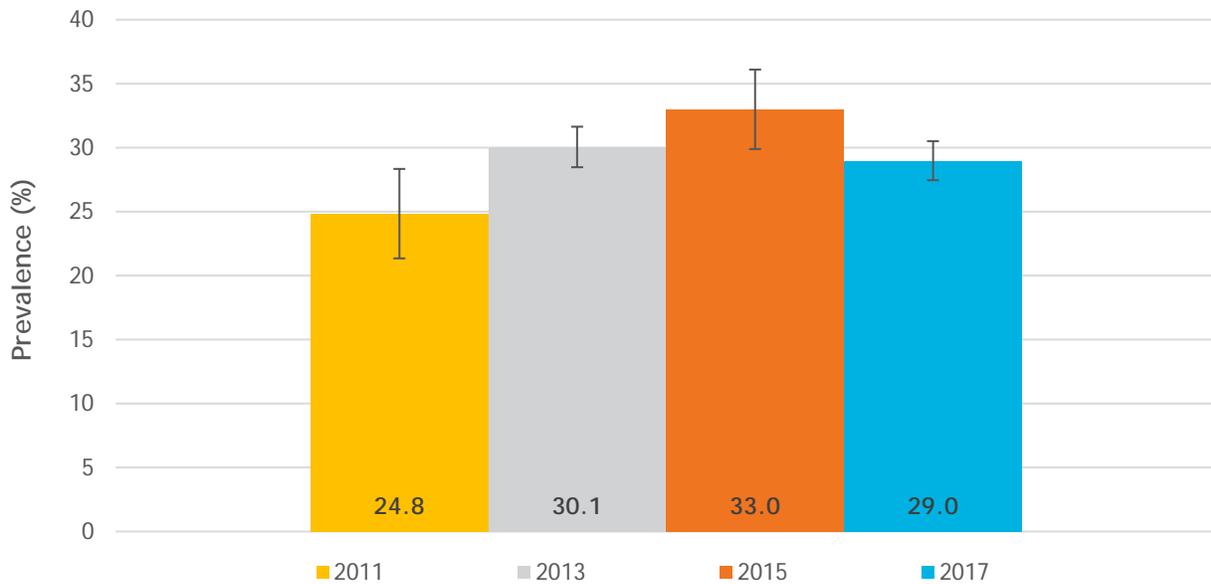
Produced by: Marijuana Health Monitoring Program, Colorado Department of Public Health & Environment 2018.  
 Data Sources: Healthy Kids Colorado Survey (HKCS).  
 \*Black bars indicate margins of error (95% Confidence Intervals).

Figure 6: Usual methods of marijuana use among Colorado high school students, 2011-2017.



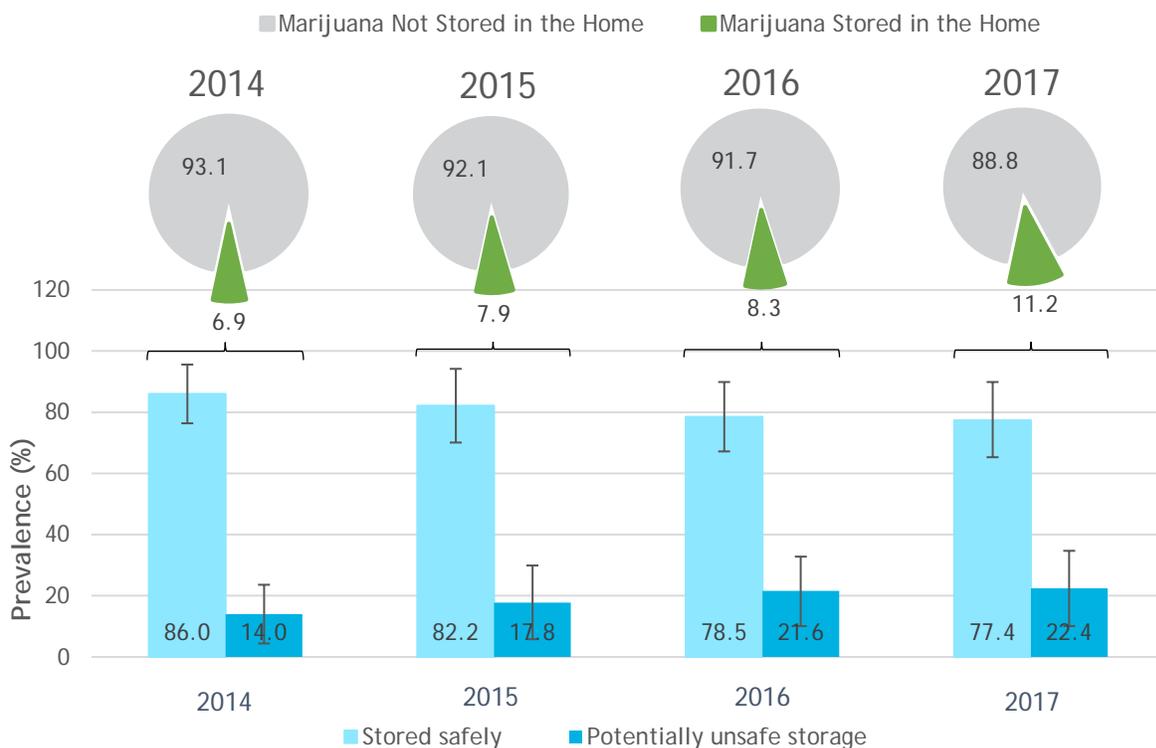
Produced by: Marijuana Health Monitoring Program, Colorado Department of Public Health & Environment 2018.  
 Data Sources: Healthy Kids Colorado Survey (HKCS).  
 \*Black bars indicate margins of error (95% Confidence Intervals).

Figure 7: Percentage of Colorado high school students who in the past 30 days rode in a car driven by someone who had been using marijuana or drove after they had been using marijuana, 2011-2017.



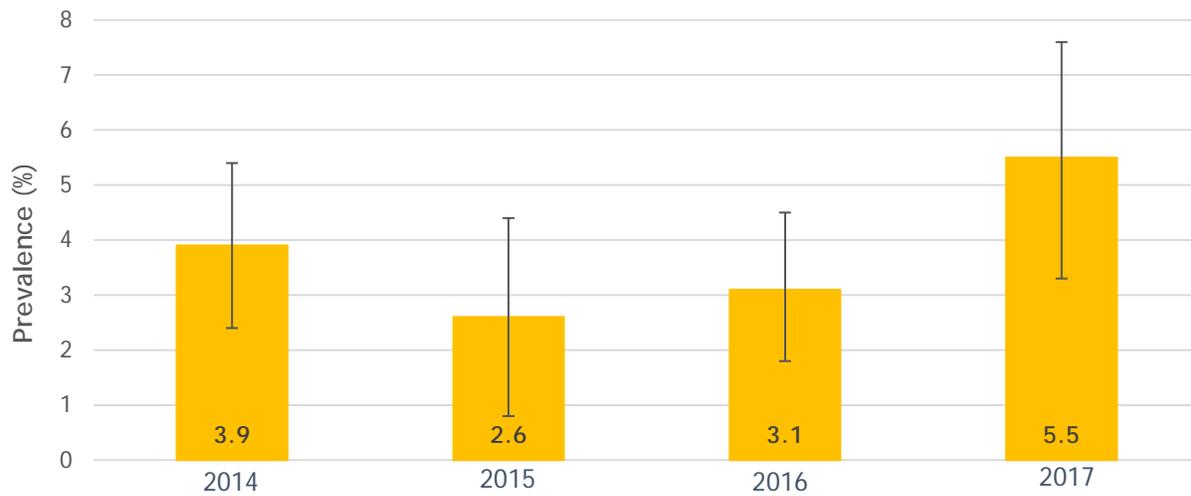
Produced by: Marijuana Health Monitoring Program, Colorado Department of Public Health & Environment 2018.  
 Data Sources: Healthy Kids Colorado Survey (HKCS).  
 \*Black bars indicate margins of error (95% Confidence Intervals).

Figure 8: Marijuana stored in Colorado homes with children, 2014-2017.



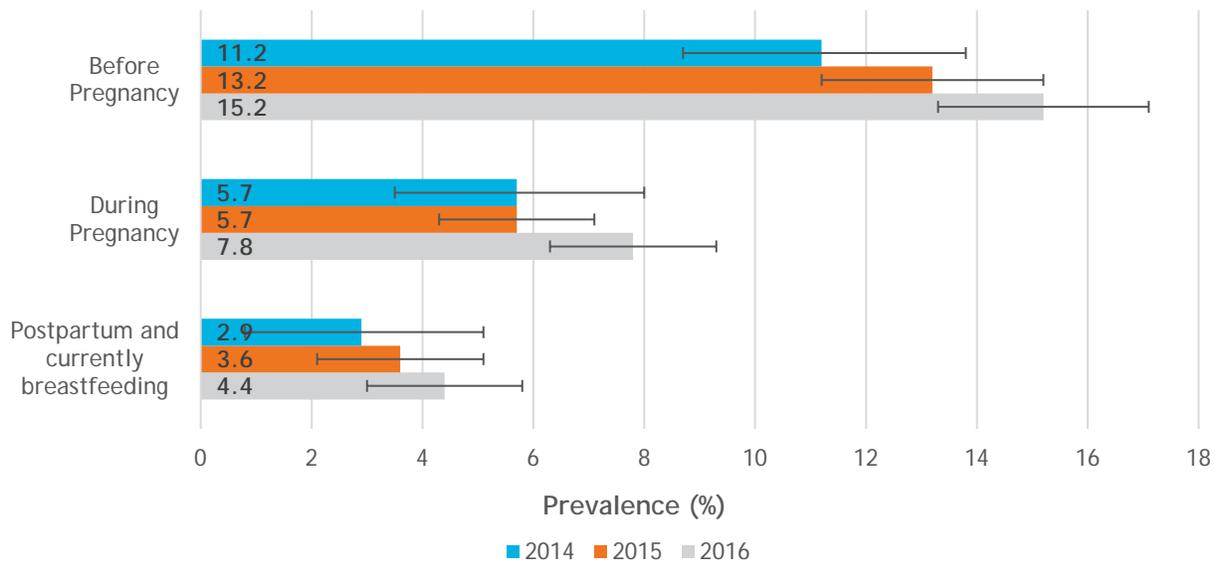
Produced by: Marijuana Health Monitoring Program, Colorado Department of Public Health & Environment 2018.  
 Data Sources: Child Health Survey (CHS).  
 \*Black bars indicate margins of error (95% Confidence Intervals).

Figure 9: Marijuana used inside Colorado homes with children, 2014-2017.



Produced by: Marijuana Health Monitoring Program, Colorado Department of Public Health & Environment 2018.  
 Data Sources: Child Health Survey (CHS).  
 \*Black bars indicate margins of error (95% Confidence Intervals).

Figure 10: Marijuana use before, during, and after pregnancy in Colorado, 2014-2016.



Produced by: Marijuana Health Monitoring Program, Colorado Department of Public Health & Environment 2018.  
 Data Sources: Pregnancy Risk Assessment Monitoring System (PRAMS).  
 \*Black bars indicate margins of error (95% Confidence Intervals).

# Section 2: Scientific Literature Review on Health Effects of Marijuana Use

## Background

The Colorado Department of Public Health and Environment (CDPHE) was given statutory (25-1.5-110, C.R.S.) responsibility to:

- "... monitor changes ... in 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."

Based on this charge, CDPHE appointed a 13-member committee, the Retail Marijuana Public Health Advisory Committee, to review scientific literature on the health effects of marijuana. Members of this committee are individuals in the fields of public health, medicine, epidemiology, and medical toxicology who demonstrate expertise related to marijuana through their work, training or research. A roster of current committee members can be found at [www.colorado.gov/marijuanahealthinfo](http://www.colorado.gov/marijuanahealthinfo). This committee was charged with the duties as outlined in 25-1.5-110 C.R.S. to "... establish criteria for studies to be reviewed, review studies and other data, and make recommendations, as appropriate, for policies intended to protect consumers of marijuana or marijuana products and the general public."

The committee has met since May 2014 to complete these duties. The overall goal is to implement an unbiased and transparent process for evaluating scientific literature and data on marijuana use and health outcomes. The committee was particularly interested in ensuring quality information is shared about the known physical and mental health effects associated with marijuana use - and also about what is unknown at present.

The committee uses a standardized systematic literature review process to search and grade the existing scientific literature on the health effects of marijuana. Findings are synthesized into evidence statements that summarize the quantity and quality of scientific evidence supporting an association between marijuana use and a health outcome.

These evidence statements are classified as follows:

- **Substantial evidence** - indicates robust scientific findings that support an association between marijuana use and the outcome.
- **Moderate evidence** - indicates scientific findings that support an association between marijuana use and the outcome, but these findings have some limitations.
- **Limited evidence** - indicates modest scientific findings that support an association between marijuana use and the outcome, but these findings have significant limitations.

- **Mixed evidence** - indicates both supporting and non-supporting scientific findings for an association between marijuana use and the outcome, with neither direction dominating.
- **Body of research failing to show an association** - indicates the topic has been researched without evidence of an association; is further classified as a limited, moderate or substantial body of research.
- **Insufficient evidence** - indicates the outcome has not been sufficiently studied to conclude whether or not there is an association between marijuana use and the outcome.

The committee also translates these evidence statements into plain language so they are understandable to the public for future use in public health messaging. In addition, the committee develops public health recommendations based on potential concerns identified through the review process and articulates research gaps based on common limitations of existing research. All of this work is performed by the full committee during open public meetings with opportunities for stakeholder input. Final statements, recommendations and research gaps are formally approved by a majority vote of the committee.

The topics for review were originally chosen in 2014 based on recently published peer-reviewed publications outlining the potential health effects of marijuana use and public health priorities identified from key informant interviews of local public health officials across Colorado, including in urban, rural, and resort communities. Since then, additional topics were added. These additional topics were collected through an ongoing process for stakeholders to submit suggestions to the committee for future topics. Key findings for each topic are presented below. More detailed findings, including information on individual studies, are available on the Literature Review tab at [www.colorado.gov/marijuanahealthinfo](http://www.colorado.gov/marijuanahealthinfo).

## Limitations

An important note for all key findings is that the available research evaluated the **association** between marijuana use and potential adverse health outcomes. This **association** does not prove that marijuana use alone **caused** the effect. Despite the best efforts of researchers to account for confounding factors, there may be other important factors related to **causality** that were not identified. In addition, marijuana use was illegal everywhere in the United States prior to 1996. Research funding, when appropriated, was commonly sought to identify adverse effects from marijuana use. This legal fact introduces both funding bias and publication bias into the body of literature related to marijuana use. Another limitation of the available research data is that most studies did not or could not measure the THC level of marijuana used by subjects, nor which other cannabinoids were present. There are diverse products now available in Colorado, many of which are likely higher in potency than the marijuana used by study subjects for much of the literature reviewed.

The Retail Marijuana Public Health Advisory Committee recognizes the limitations and biases inherent in the published literature and made efforts to ensure the information reviewed and synthesized is reflective of the current state of medical knowledge. Where information was lacking - for whatever reason - the committee identified this knowledge gap and recommended further research. This information will be updated as new research becomes available.

## Summary of key findings

### Marijuana use among adolescents and young adults

The committee reviewed the relationships between adolescent and young adult marijuana use and cognitive abilities, academic performance, mental health and future substance use. Weekly marijuana use by adolescents is associated with deficits in learning, memory, math and reading skills, even 28 days after last use. Weekly use is also associated with failure to graduate from high school or complete a college degree. Adolescents and young adults who use marijuana are more likely to experience psychotic symptoms as adults, such as hallucinations, paranoia, and delusional beliefs. Evidence shows that adolescents who use marijuana can become addicted to marijuana, and that treatment for marijuana addiction can decrease use and dependence. Additionally, those who quit using marijuana have lower risks of adverse cognitive and mental health outcomes than those who continue to use.

### Marijuana use and cancer

The committee reviewed different forms of cancer relative to marijuana use, as well as the chemicals released in marijuana smoke and vapor. Strong evidence shows marijuana smoke contains many of the same cancer-causing chemicals found in tobacco smoke. However, there is conflicting research for whether or not marijuana smoking is associated with lung cancer. Marijuana use is associated with testicular cancer, and limited evidence also suggests an association between marijuana use and prostate cancer. On the other hand, the limited evidence available concerning cancers of the bladder, head and neck suggests they might not have any association with marijuana use.

### Marijuana use and cardiovascular effects

The committee reviewed myocardial infarction, stroke and death from cardiovascular causes, relative to marijuana use. Limited scientific evidence shows that marijuana use may increase the risk of heart attack, and the risk of stroke in individuals younger than 55. Quality research is lacking concerning other cardiovascular events and conditions, including death.

### Marijuana dose and drug interactions

The committee reviewed THC (tetrahydrocannabinol, the main psychoactive component of marijuana) levels relative to marijuana dose and method of use, the effects of secondhand marijuana smoke, drug-drug interactions involving marijuana, and relationships between marijuana and opioid use. One important finding is that it can take up to four hours after consuming an edible marijuana product to reach the peak THC blood concentration and feel the full effects. There is credible evidence of clinically important drug-drug interactions between marijuana and multiple medications, including some anti-seizure medications and a common blood-thinner. Data about potential interactions are lacking for many drugs at this time and are likely to evolve substantially in the coming years. There is some evidence that hospitalizations and deaths due to opioid pain medication overdose are less prevalent in states with legal and accessible medical marijuana compared to states

without. There is conflicting evidence for whether or not marijuana use is associated with a decrease in opioid use among chronic pain patients or individuals with a history of problem drug use. Research is lacking concerning the health effects of secondhand marijuana smoke exposure.

### **Marijuana use and driving**

The committee reviewed driving impairment and motor vehicle crash risk relative to marijuana use, as well as evidence indicating how long it takes for impairment to resolve after marijuana use. The risk of a motor vehicle crash increases among drivers with recent marijuana use. In addition, using alcohol and marijuana together increases impairment and the risk of a motor vehicle crash more than using either substance alone. For less-than-weekly marijuana users, using marijuana containing 10 milligrams or more of THC is likely to impair the ability to safely drive, bike or perform other safety-sensitive activities. Less-than-weekly users should wait at least six hours after smoking or eight hours after eating or drinking marijuana to allow time for impairment to resolve. Research is lacking on marijuana and impairment in frequent marijuana users.

### **Marijuana use and gastrointestinal or reproductive effects**

The committee reviewed gastrointestinal diseases, particularly cyclic vomiting, and infertility or abnormal reproductive function. Evidence shows that long-time, daily or near daily marijuana use is associated with cyclic vomiting. This condition has been called cannabinoid hyperemesis syndrome. In such cases, stopping marijuana use may relieve the vomiting. There is conflicting research regarding whether or not marijuana use is associated with infertility or abnormal reproductive function, for both men and women.

### **Marijuana use and injury**

The committee reviewed workplace, recreational and other non-driving injuries, burns from hash-oil extraction or failed electronic smoking devices, and physical dating violence. Evidence shows marijuana use may increase the risk of workplace injury while impaired, but is unclear for other types of non-driving-related injury. There have been many reports of severe burns resulting from home-extraction of butane hash oil leading to explosions, and cases of electronic smoking devices exploding, leading to trauma and burns. Concerning dating violence, adolescent girls who use marijuana may be more likely to commit physical violence against their dating partners, and adolescent boys who use marijuana may be more likely to be victims of physical dating violence.

### **Marijuana use and neurological, cognitive and mental health effects**

The committee reviewed the potential relationships between marijuana use and cognitive impairment, mental health disorders and substance abuse among adults. Strong evidence shows that those who use marijuana daily or near daily are more likely to have impaired memory lasting more than a week after quitting. An important acute effect of THC is psychotic symptoms, such as hallucinations, paranoia and delusional beliefs during intoxication. These symptoms are worse with higher doses. Daily or near daily marijuana use is associated with developing a psychotic disorder such as schizophrenia. Finally, evidence shows marijuana users can experience withdrawal and become addicted to marijuana, and treatment for marijuana addiction can decrease use and dependence.

## **Marijuana use during pregnancy and breastfeeding**

The committee reviewed adverse birth outcomes, effects of prenatal marijuana use on exposed offspring later in childhood or adolescence and effects of marijuana use by a breastfeeding mother. Biological evidence shows THC passes through the placenta to the fetus, so the unborn child is exposed to THC if the mother uses marijuana, and THC passes through breast milk to a breastfeeding child. Marijuana use during pregnancy may be associated with an increased risk of heart defects in offspring or stillbirth. Stronger evidence was found for effects that are seen in the exposed offspring months or years after birth if a child's mother used marijuana while pregnant with the child. These include decreased growth and impaired cognitive function and attention. Decreased academic ability or increased depression symptoms may also occur.

## **Marijuana use and respiratory effects**

The committee reviewed respiratory diseases such as chronic obstructive pulmonary disorder (COPD), chronic bronchitis and asthma, respiratory infections and lung function relative to smoked marijuana. It also reviewed potential health effects of vaporized marijuana. Strong evidence shows an association between daily or near daily marijuana use and chronic bronchitis, with cough, wheezing and mucus. Additionally, daily or near daily marijuana use may be associated with bullous lung disease and pneumothorax in individuals younger than 40 years of age. Frequent smokers who switch from marijuana smoking to marijuana vaporizing may have fewer respiratory symptoms and improved pulmonary function. Finally, a notable effect of acute use is a short-term improvement in lung airflow.

## **Unintentional marijuana exposures in children**

The committee reviewed unintentional marijuana exposure relative to marijuana legalization and child-resistant packaging. They found strong evidence that more unintentional marijuana exposures of children occur in states with increased legal access to marijuana, and that exposures can lead to significant clinical effects requiring hospitalization. Additionally, evidence shows child-resistant packaging prevents exposure to children from potentially harmful substances, such as THC.

The following tables includes the committee's most prominent findings from reviews of scientific literature on marijuana use and potential health effects.

## Marijuana use among adolescents and young adults

	Substantial evidence	Moderate evidence
<b>Benefits of quitting</b>	Treatment for cannabis use disorder can reduce use and dependence	Quitting marijuana use lowers the risk of adverse mental health effects
<b>Cognitive and academic effects</b>	Weekly use is associated with a lower rate of graduating high school	Weekly use is associated with a lower rate of attaining a college degree (among those who start a degree program)
<b>Mental health</b>	Daily or near daily use is associated with future psychotic disorders like schizophrenia	
	Use is associated with future psychotic symptoms (likelihood increases with more frequent use)	
<b>Substance use, abuse, and addiction</b>	Those who use marijuana can develop cannabis use disorder (addiction)	
	Marijuana use is associated with future use and use disorder for alcohol, tobacco and other drugs	
	Marijuana use is associated with future increased marijuana use and use disorder	

## Marijuana use and cancer

	Substantial evidence	Moderate evidence
<b>Chemicals in MJ smoke or vapor</b>	Marijuana smoke contains many of the same cancer causing chemicals as tobacco smoke	
<b>Cancer and precancerous lesions</b>	Daily or near daily use is associated with pre-cancerous lesions in airway	Use is associated with increased risk of nonseminoma testicular cancer

## Marijuana dose and drug interactions

	Substantial evidence	Moderate evidence
<b>THC levels</b>	It takes up to four hours after ingesting marijuana (edible products) to reach peak blood THC levels	Ingesting more than 15 mg THC may produce a blood THC level above 5 ng/mL
	Smoking more than 10 mg THC produces a blood THC level near or above 5 ng/mL within 10 minutes	Inhaling vaporized THC produces a blood THC level similar to smoking the same dose
<b>Secondhand exposure</b>	Typical secondhand marijuana smoke exposure is unlikely to cause a positive drug screen by urine or blood	

## Marijuana use and driving

	Substantial evidence	Moderate evidence
<b>Impairment and crash risk</b>	Recent marijuana use by a driver increases the risk of a motor vehicle crash	Higher THC blood level increases the risk of a motor vehicle crash
	Combined use of marijuana and alcohol increases crash risk more than either substance alone	Blood THC levels of impaired drivers are higher now than they were in the past
	Smoking more than 10 mg THC may lead to driving impairment*	
	Orally ingesting more than 10 mg THC may lead driving impairment*	
	Increased risk of driving impairment at blood THC as low as 2-5 ng/mL*	
<b>Time to wait before driving</b>	Waiting at least 6 hours after smoking less than 18 mg allows driving impairment to resolve or nearly resolve*	Waiting at least 6 hours after smoking about 35 mg allows driving impairment to resolve or nearly resolve*
	Waiting at least 8 hours after orally ingesting less than 18 mg allows driving impairment to resolve or nearly resolve*	

### Marijuana use and gastrointestinal and reproductive effects

	Substantial evidence	Moderate evidence
Cyclic vomiting		Cyclic vomiting can occur with long-time, daily or near daily marijuana use (cannabinoid hyperemesis syndrome)

### Marijuana use and neurological, cognitive, mental health effects

	Substantial evidence	Moderate evidence
Cognitive effects	Daily or near daily use is associated with Impaired memory for at least 7 days	
Mental health effects	Use is associated with acute psychotic symptoms during intoxication	
	Daily or near daily use is associated with future psychotic disorders like schizophrenia	

**Marijuana use and neurological, cognitive, mental health effects (Continued)**

	Substantial evidence	Moderate evidence
<b>Substance use, abuse and addiction</b>	Those who use marijuana can develop cannabis use disorder (addiction)	
	Treatment for cannabis use disorder can reduce use and dependence	
	Those using daily or near daily can experience withdrawal symptoms when abstaining	

**Marijuana use during pregnancy and breastfeeding**

	Substantial evidence	Moderate evidence
<b>Effects on exposed offspring</b>		Prenatal marijuana exposure is associated with decreased cognitive function in childhood
		Prenatal marijuana exposure is associated with attention problems in childhood

### Biological evidence concerning marijuana use during pregnancy and breastfeeding

THC is present in the breast milk of women who use marijuana. Infants who drink breast milk containing THC absorb and metabolize the THC.

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### Marijuana use and respiratory effects

	Substantial evidence	Moderate evidence
Smoked marijuana	Use is associated with chronic bronchitis with cough, wheezing and mucus	
	Acute use is associated with short-term lung airflow improvement	

### Unintentional marijuana exposure in children

	Substantial evidence	Moderate evidence
	Legal marijuana access increases unintentional marijuana exposures in children	Child-resistant packaging reduces unintentional pediatric poisonings

## Public health recommendations

It is important to improve data quality by systematically collecting information on the frequency, amount, potency and method of marijuana use in both public health surveillance and medical care settings. Clinicians should routinely screen for marijuana use during hospitalizations and emergency department visits, and follow-up questions should clarify the timing and amount of last use. Improved testing methods and documentation are needed when testing drivers involved in motor vehicle crashes or suspected of driving under the influence of drugs (DUID).

Questions regarding marijuana use should be continued on population-based surveys such as the Behavioral Risk Factor Surveillance System (BRFSS), the Healthy Kids Colorado Survey (HKCS) and Pregnancy Risk Assessment Monitoring System (PRAMS). Surveillance methods should be expanded to collect more detailed information, such as quantity and methods of use, perceptions of risk, reasons for using and adverse effects experienced. To better assess potential health impacts, data on hospitalizations and emergency department visits related to marijuana use should be further explored to identify diagnoses more prevalent among those who use marijuana and to clarify when marijuana was or was not a likely contributor to a hospitalization or ED visit.

Public education on potential health effects of marijuana is important, particularly related to the effects of use during pregnancy, adolescent use, driving after using and unsafe storage around children. Marijuana dispensaries and representatives of the marijuana industry should continue to partner with public health in disseminating education about these topics of highest concern. Education for health care providers on the need for marijuana use screening and the known health effects of marijuana use may encourage more open dialog between providers and patients.

## Research gaps

Important research gaps related to the health effects of marijuana use were identified during the literature and data review process. These research gaps were based on frequently noted limitations of existing research or issues important to public education or policymaking.

Research gaps particularly important to public health and safety include the need for: 1) research on the effects of marijuana use on pregnant women and their offspring, including marijuana use concurrent with breastfeeding; 2) research on marijuana containing THC levels consistent with currently available products (higher THC); 3) research on health effects among individuals who have used marijuana frequently for a long period of time; 4) research on driving impairment among people who use marijuana more than weekly and may have developed tolerance; and 5) research to better characterize the pharmacokinetics/ pharmacodynamics, potential drug interactions, health effects, and impairment related to non-smoking methods of marijuana use such as edibles and vaporizing as well as other cannabinoids such as cannabidiol (CBD); 5) research to better describe the risk of adverse health effects due to marijuana contamination related to fungi, heavy metals, and pesticides.

Two areas that could be improved in new research are measurements of marijuana exposures and measurements of health outcomes. Studies should use better and more standardized indicators of marijuana use, including frequency, dose, and route of exposure of marijuana use, length of abstinence, and cumulative lifetime marijuana exposure. A particularly important need is the separate evaluation of health effects among those who use daily or near daily and those who use less frequently. Researchers should also consider stratifying study groups by age, gender or other characteristics when the health effect being studied could differ among these groups, such as by age for cardiovascular effects or by gender for mental health effects. Finally, one strong step toward providing valuable research data on would be a community based cohort to study both beneficial and adverse health effects of marijuana use.

Identifying these research gaps helps researchers and funding sources to prioritize areas of research related to marijuana use and public health. While outside the scope of this committee's duties, the committee also recognizes the need for more research on the potential therapeutic benefits of marijuana. The committee strongly recommends Colorado continue to support research to fill these important gaps in public health knowledge.

# Section 3: Monitoring Marijuana-Related Health Effects in Colorado

## Background

This chapter reviews surveillance efforts of the Colorado Department of Public Health and Environment (CDPHE) to monitor the potential population-based health effects of legalized marijuana. Through 25-1.5-110, C.R.S., CDPHE was given statutory authority to:

“... 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.”

The purpose of this data collection and analysis was stated in 25-1.5-110 C.R.S. to “... monitor the emerging science and medical information relevant to the health effects associated with marijuana use.” The data analyses reported in this chapter were reviewed by the Retail Marijuana Public Health Advisory Committee as outlined in 25-1.5-110 C.R.S. to help “... make recommendations as appropriate, for policies intended to protect consumers of marijuana or marijuana products and the general public.”

This section covers analysis of two secondary datasets used to monitor: 1) reported exposures to marijuana and other toxic substances and 2) hospital and emergency department visits involving marijuana.

## Data sources

### Rocky Mountain Poison and Drug Center data

The Rocky Mountain Poison and Drug Center (RMPDC) provides medical information to health care providers and the public to reduce toxicity, injury, and disease related to exposures of all kinds. RMPDC has been providing information and assistance to Colorado and the surrounding region for more than 50 years. RMPDC participates in the American Association of Poison Control Centers’ National Poison Data System (NPDS). RMPDC and NPDS data are used by public health, pharmaceutical and medical institutions for research, education and prevention initiatives in Colorado and throughout the nation. Poison center call volume data are typically used as a surrogate data source to determine the potential for adverse health effects from exposure to chemicals, environmental agents, biotoxins and drugs. RMPDC data are a near “real-time” data source available to public health professionals. This section examines the number of individuals exposed to marijuana that were reported via calls to RMPDC from 2000 to 2017. Also examined are potential trends in the number of individual exposures reported related to marijuana over time and legalization periods.

### Colorado Hospital Association data

The Colorado Hospital Association (CHA) manages administrative data on hospitalizations and emergency department (ED) visits from participating member hospitals in Colorado. The data include patient demographics, visit characteristics, admission and discharge dates, discharge diagnosis/billing codes, and procedure codes.

Coding is assigned by the facility per the International Classification of Diseases Clinical Modification (ICD-CM) manual. The majority of acute care hospitals and emergency departments in Colorado are included in this data source. The following definitions were used to examine rates of marijuana-related billing codes in hospitalizations and ED visits:

- **Definition 1: Marijuana-related billing codes** included any hospitalization or ED visit with at least one marijuana-related ICD-9/10-CM billing code in the up to 30 listed billing codes for each visit.
- **Definition 2: Marijuana poisoning billing codes** included any hospitalization or ED visit with at least one marijuana poisoning ICD-9/10-CM billing code in the up to 30 listed billing codes for each visit.

## Limitations

The poison center call data are limited in that it is a voluntary reporting system; not every person experiencing marijuana-related adverse health symptoms or requiring medical attention following a marijuana exposure reports it to the poison center. Additionally, a large proportion of calls to the poison center reporting marijuana exposures come from healthcare providers seeking additional information around treatment of marijuana exposures. As providers learn how to manage exposures, the reported marijuana exposures to the poison center may decrease. Nevertheless, these data reveal important trends to monitor through time.

It is important to consider the limitations of CHA data to avoid misinterpreting these findings. The codes used in this data are intended for billing purposes. Presence of marijuana-related code(s) does not indicate that marijuana exposure caused the healthcare encounter or caused an adverse health effect, and may indicate increased marijuana exposure or use in the community. Use of marijuana-related billing codes has not been standardized or validated. However, this data source is the best currently available for monitoring trends in potential adverse health effects related to marijuana.

The hospital and ED visit data are limited in that they rely on billing codes to identify marijuana involvement. Billing codes do not indicate if marijuana use caused the healthcare encounter, but identify that marijuana use was discussed in the patient's care during that encounter. It may capture provider's routine screening for marijuana use, the patient reporting marijuana use, or referral to counseling for marijuana use cessation. It may also include past histories of marijuana use, acute intoxications of marijuana, marijuana effects that lead to adverse health symptoms like hyperemesis, or trauma caused by motor vehicle crashes resulting from marijuana intoxication.

## Summary of key findings

The most prominent findings from Rocky Mountain Poison and Drug Center and Colorado Hospital Association data are described below. All findings and detailed results of these data sources can be found at: [www.colorado.gov/marijuanahealthinfo](http://www.colorado.gov/marijuanahealthinfo).

## Rocky Mountain Poison and Drug Center data

### Overall number of marijuana exposure calls consistent since 2014

The number of reported human marijuana exposure reported to RMPDC has increased since the commercialization of marijuana in Colorado, however remains far less compared to alcohol exposures (Figure 11). From 2000 to 2009, the number of reported marijuana exposures remained fairly consistent. In 2010, the year medical marijuana stores opened, total reported marijuana exposures doubled from 44 to 95. From 2010 to 2013, reported marijuana exposures increased to 127. With legalized retail stores opening in 2014, reported marijuana exposures to RMPDC increased to 223. Since 2014, reported marijuana exposures have remained consistent, with 222 reported in 2017.

### Most calls involve intentional exposures to marijuana only (no other substances involved)

The majority of marijuana exposures reported to the poison center involve marijuana only, with fewer exposures involving marijuana and other drugs (Figure 12). Reported exposures involving marijuana only was higher in 2017 at 178 compared to 2016 at 147, and exposure to marijuana and other substances decreased from 80 in 2016 to 44 in 2017. In 2017, numbers of intentional marijuana exposures (148) are higher than unintentional marijuana exposures (68), but both have remained stable since 2014.

### Calls due to unintentional exposures in children continue slow upward trend

The number of marijuana exposures reported to poison center remained high among young children and were largely due to unintentional consumption of marijuana or marijuana products. Reported marijuana exposures to the poison center in children ages 0-8 years averaged 5 per year from 2000 to 2009 (Figure 13). A steady increase in exposures of this age group began in 2012, the same year retail marijuana was legalized. Marijuana exposures in this age group increased again from 27 in 2013 to 45 in 2014, coinciding with the opening of retail stores. In 2017, reported unintentional exposures of marijuana only in children 0-8 continued an upward trend from 40 in 2016 to 50 in 2017 as well as overall reported marijuana exposures in children 0-8 (50 in 2016 to 64 in 2017). Nearly all exposures reported for children ages 0-8 years were unintentional exposures to marijuana only in all time periods. Data on the type of marijuana product involved in these exposures was available beginning in July 2014. In 2017, edible marijuana products comprised 65.6 percent of all exposures in children ages 0-8 years, followed by smokable products (23.4 percent), and other marijuana products (10.9 percent).

### Highest number of calls from adults over 25

Reported marijuana exposures in ages 9-17 years averaged 17 per year from 2000-2009, peaked at 64 in 2015 and dropped to 47 in 2016. Ages 18-24 years averaged 17 exposures per year from 2000-2009 and increased to 40 in 2016, but dropped to 20 in 2017. The highest number of reported marijuana exposures to the poison center are concerning adults age 25 years and older. This age group also had the largest increase in the number of reported marijuana exposures, averaging 15 exposures per year from 2000 to 2009 and peaking at 92 exposures in 2014. Calls in this age group declined to 69 in 2017 but remain increased compared to 36 in 2013. The majority of

exposures in adult age groups were intentional and involved smokable marijuana products. However, the number of exposures involving smokable marijuana products decreased from 95 in 2016 to 62 in 2017.

## Colorado Hospital Association data

### Emergency department visits with marijuana-related billing codes increased slightly in 2017

In 2017, ED visits with marijuana-related billing codes (definition 1) slightly increased overall from 1,065 per 100,000 ED visits in 2016 to 1,139 per 100,000 ED visits in 2017. Rates of ED visits with marijuana-related billing codes (definition 1) were highest among males (1,500 per 100,000 ED visits), young adults 18-25 years old (2,352 per 100,000 ED visits), and African Americans (1,727 per 100,000 ED visits).

### Hospitalizations with marijuana-related billing codes decreased in 2017

Hospitalizations with marijuana-related billing codes (definition 1) decreased overall from 3,517 per 100,000 hospitalizations in 2016 to 3,439 per 100,000 hospitalizations in 2017. Rates of hospitalizations with marijuana-related billing codes were highest among males (4,734 per 100,000 hospitalizations), adolescents 9-17 years old (7,974 per 100,000 hospitalizations), young adults 18-25 years old (9,852 per 100,000 hospitalizations), and African Americans (6,648 per 100,000 hospitalizations) (definition 1).

### Rates of ED visits and hospitalizations with marijuana-related billing codes are lower than alcohol

The rates of hospitalizations and emergency department (ED) visits with marijuana-related billing codes (definition 1) have remained lower than those with alcohol-related billing codes since 2000 for hospitalizations and 2011 for ED visits. Among ED visits, the rate of marijuana-related billing codes (definition 1) has remained higher than the rates of stimulant-, cocaine-, and opioid-related billing codes, but lower than alcohol-related billing codes (Figure 14). Among hospitalizations, rates with marijuana-related billing codes were similar to rates of opioid-related billing codes until 2013 when marijuana-related billing codes began increasing at a higher rate than opioid-related billing codes (Figure 15). Both the rates of hospitalizations with all marijuana-billing codes and hospitalizations with opioid-related billing codes were higher than those with cocaine- and stimulants-related billing codes since 2000. Rates of hospitalizations with alcohol-related billing codes remain the highest of all substances.

### Rates of hospitalizations and ED visits with marijuana poisoning billing codes continue upward trend

The rate of emergency department (ED) visits with marijuana poisoning billing codes (definition 2) in children under 9 years old have increased over time since 2011 (Figure 16). The rates of both hospitalizations and ED visits with marijuana poisoning billing codes in children under 9 years were 20.8 per 100,000 hospitalizations and 20.3 per 100,000 ED visits in 2017, not statistically different than the rates in 2016. In 2017, the overall highest rates of hospitalizations (110 per 100,000) and ED visits (80 per 100,000) with marijuana poisoning billing codes were in young adults ages 18-25 years old.

## Discussion

The data presented from the poison center and Colorado Hospital Association provide important insights into the potential health effects and public health impacts associated with marijuana use. Overall in 2017, most marijuana exposures and adverse health effects possibly due to marijuana were relatively stable or decreased compared to 2016. However, all remain higher in 2017 compared to pre-legalized retail marijuana stores opening in 2014. Importantly, the overall trends do not tell the whole story. Exposures calls and emergency department visits and hospitalizations among young children continue a slow upward trend.

### Encouraging trends

- The overall number of marijuana exposure calls to the poison center have been consistent since 2015.
- The overall rate of emergency department visits with all marijuana-related billing codes (definition 1) was slightly increased in 2017 compared to 2016, and the rates of hospitalizations with all marijuana-related billing codes (definition 1) decreased from 2016 to 2017.

### Trends to continue monitoring

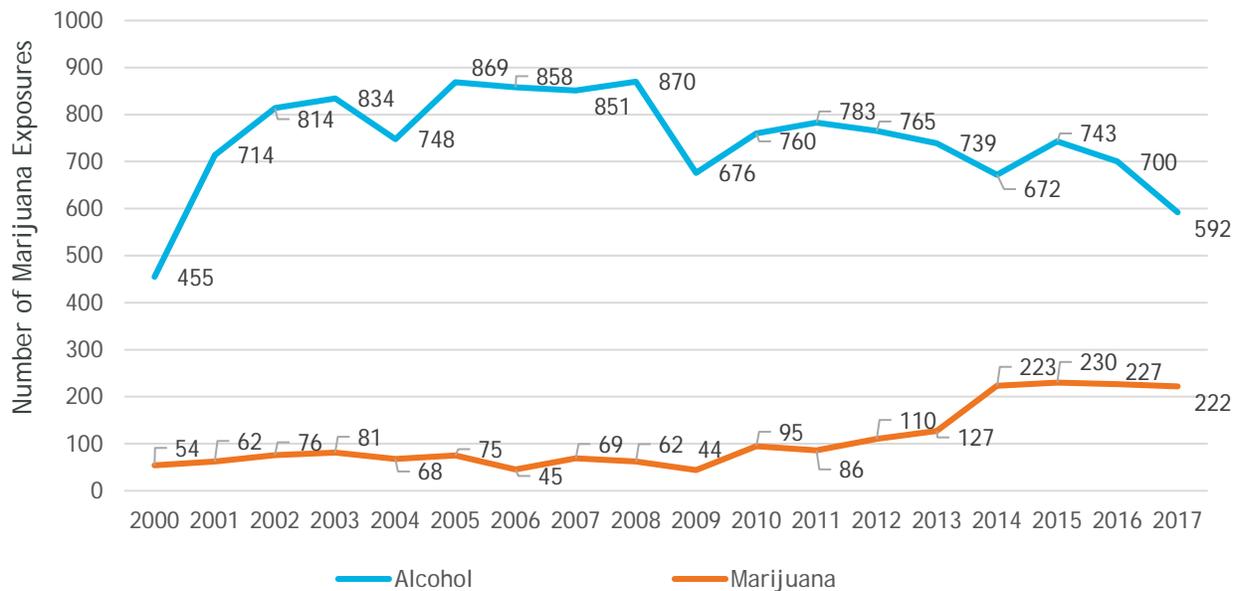
- Marijuana exposure calls to the poison center continue to be higher in years after marijuana commercialization (2010-2017) compared to years prior (2000-2009), including calls about children 0-8 years old with unintentional marijuana exposure.
- Edible marijuana products were involved in 45 percent of marijuana exposures reported to the poison center in 2017. Exposures to edible marijuana products in children 0-8 years old comprised 65 percent of all marijuana exposures in this age group.
- The overall rate of hospitalizations with all marijuana-related billing codes (definition 1) has increased each year from 2008 to 2016. Though the rate decreased in 2017, it is important to continue monitoring this trend as the current rate is 93% higher than in 2013.
- In 2017, 10 percent of all hospitalizations and 2 percent of all emergency department visits in young adults (ages 18-25 years) had marijuana-related billing code(s) (definition 1). This was higher than the rate among other age groups, and likely reflects the higher rate of marijuana use in young adults.
- Disparities in hospitalizations and emergency department visits with all marijuana-related billing codes (definition 1) also existed by sex and race, with higher rates among males and African Americans.

### Recommendations and future directions

1. Until a validated case definition is developed, CDPHE should continue using reported exposures to the poison center and hospital and emergency department discharges to monitor trends in potential marijuana-related adverse health effects.
2. Continue to monitor reported marijuana exposures to the poison center, including intentionality and type of marijuana exposure. CDPHE and RMPDC are working together on a surveillance project that captures additional information such as product name, source, and potency in reported marijuana exposures. CDPHE will work with RMPDC to monitor this new data source.

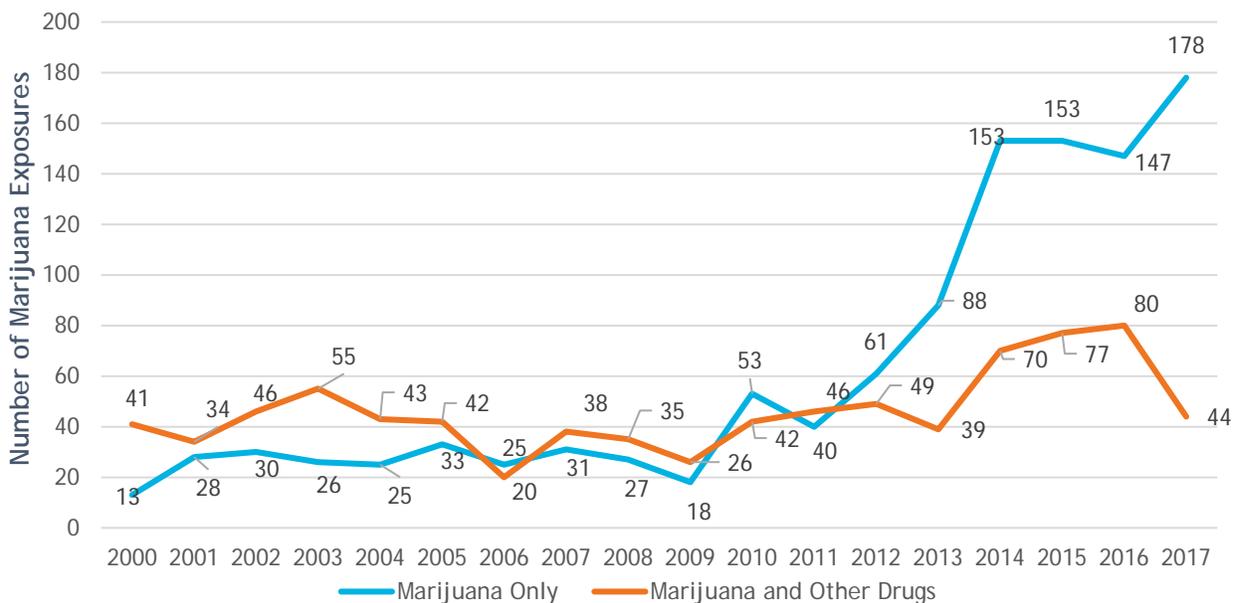
3. Perform more detailed analyses on unintentional exposures to marijuana in children under age 9. This includes collecting additional primary data from medical records to assess the severity of the outcome, the source of the exposure and possible public health intervention strategies.
4. Further analyze hospitalization and emergency department billing codes data to assess primary diagnoses in relation to marijuana-related billing codes.
5. Continue to partner with other state and local agencies to collect new data regarding marijuana use associated with adverse health events, injury or death.
6. More large prospective studies are needed to identify health outcomes more definitively linked to acute and chronic marijuana use.
7. Consensus recommendations from national organizations on how to monitor marijuana-related adverse health effects for the general population and for conditions that may be associated with marijuana use are needed to guide state and national surveillance.

Figure 11: Number of human marijuana exposures compared to number of human alcohol exposures to the Rocky Mountain Poison and Drug Center (1/1/00-12/31/17) in Colorado.



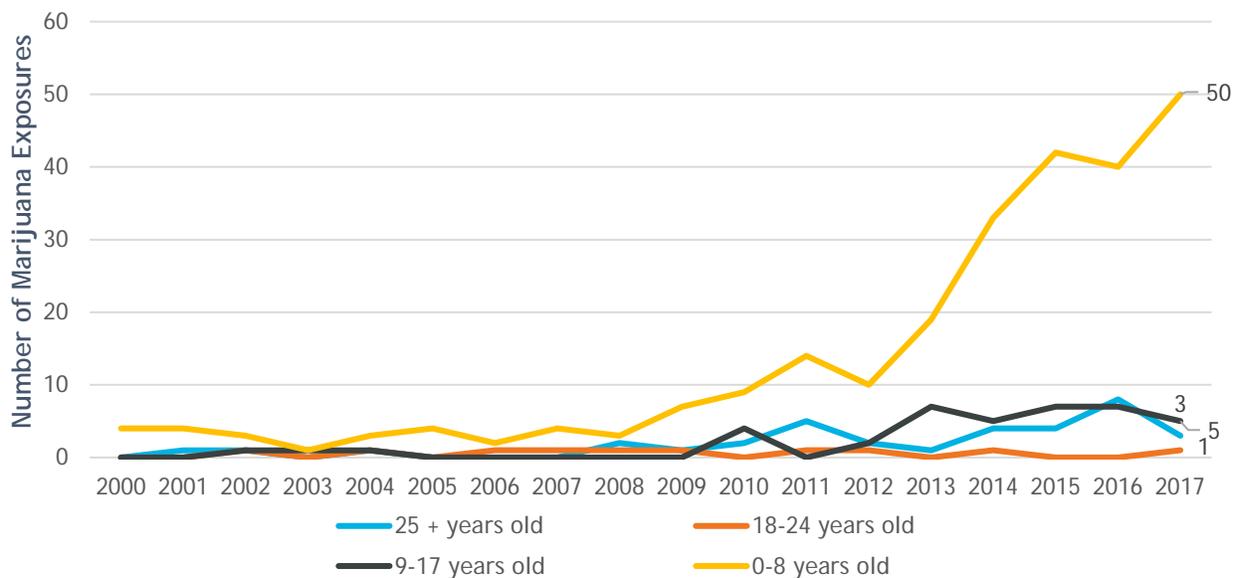
Produced by: Marijuana Health Monitoring Program, Colorado Department of Public Health & Environment 2018.  
Data Sources: National Poison Data System (NPDS).

Figure 12: Marijuana only or marijuana with other drugs exposures reported to the Rocky Mountain Poison and Drug Center (1/1/00-12/31/17) in Colorado.



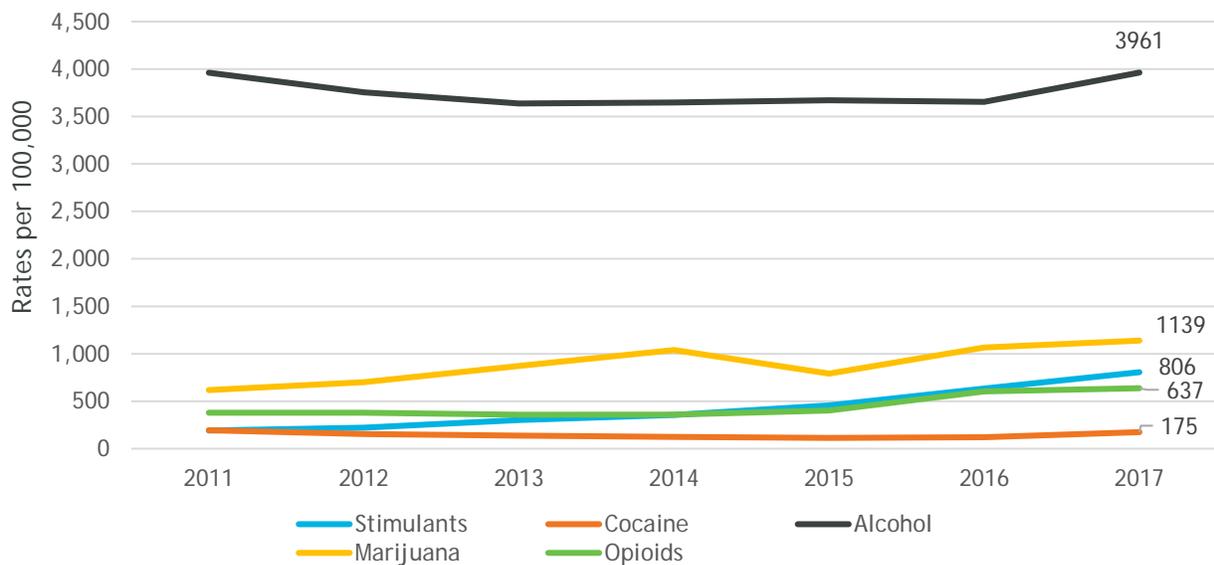
Produced by: Marijuana Health Monitoring Program, Colorado Department of Public Health & Environment 2018.  
Data Sources: National Poison Data System (NPDS).

Figure 13: Unintentional marijuana only exposures reported to the Rocky Mountain Poison and Drug Center (1/1/00-12/31/17) in Colorado by age group.



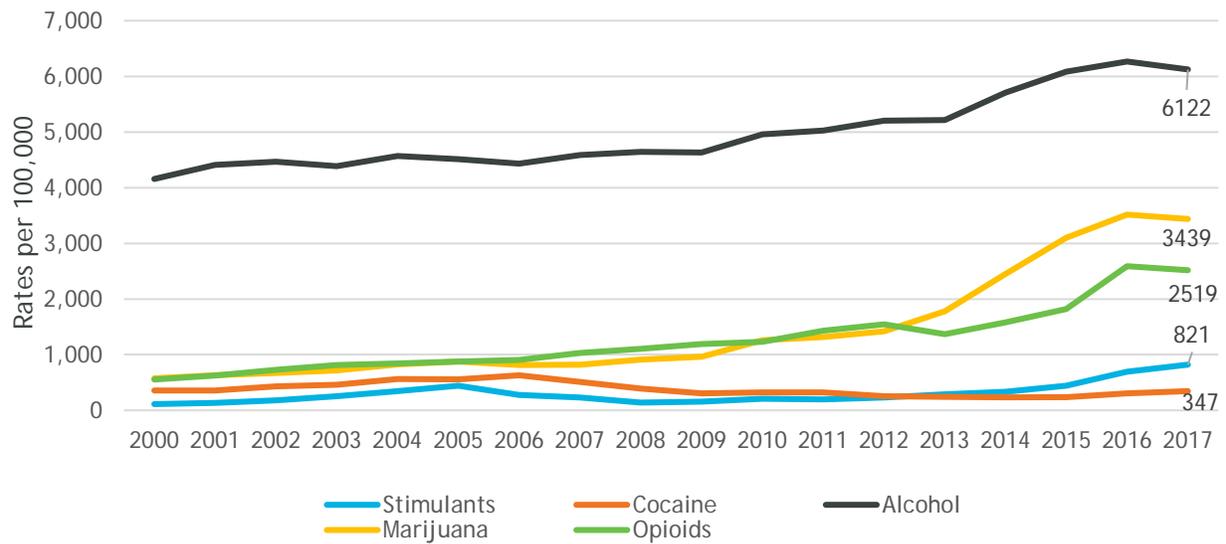
Produced by: Marijuana Health Monitoring Program, Colorado Department of Public Health & Environment 2018.  
Data Sources: National Poison Data System (NPDS).

Figure 14: Rates of emergency department visit with substance-related billing codes in Colorado, 2011-2017.



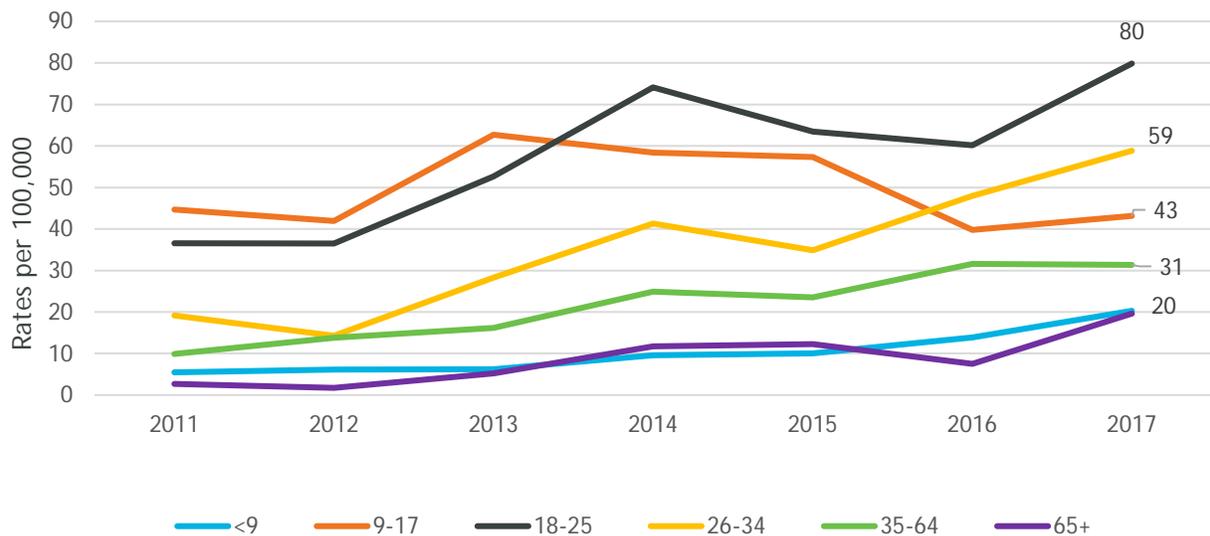
Produced by: Marijuana Health Monitoring Program, Colorado Department of Public Health & Environment 2018.  
Data Sources: Colorado Hospital Association (CHA).  
Marijuana-related ICD-9/10-CM billing codes included at least one of the following cannabis codes in the up to 30 discharge diagnosis/billing codes: accidental poisoning by psychodysleptics (E854.1), poisoning by psychodysleptics (969.6), poisoning, adverse effects and underdosing by cannabis (T40.7), cannabis abuse (305.2 & F12.1), cannabis dependence (304.3 & F12.2), and cannabis use (F12.9).

Figure 15: Rates of hospitalizations with substance-related billing codes in Colorado, 2000-2017.



Produced by: Marijuana Health Monitoring Program, Colorado Department of Public Health & Environment 2018.  
 Data Sources: Colorado Hospital Association (CHA).  
 Marijuana-related ICD-9/10-CM billing codes included at least one of the following cannabis codes in the up to 30 discharge diagnosis/billing codes: accidental poisoning by psychodysleptics (E854.1), poisoning by psychodysleptics (969.6), poisoning, adverse effects and underdosing by cannabis (T40.7), cannabis abuse (305.2 & F12.1), cannabis dependence (304.3 & F12.2), and cannabis use (F12.9).

Figure 16: Rates of emergency department visit with poisonings possibly due to marijuana in Colorado, 2011-2017.



Produced by: Marijuana Health Monitoring Program, Colorado Department of Public Health & Environment 2018.  
 Data Sources: Colorado Hospital Association (CHA).  
 Marijuana-related ICD-9/10-CM billing codes included at least one of the following cannabis codes in the up to 30 discharge diagnosis/billing codes: accidental poisoning by psychodysleptics (E854.1), poisoning by psychodysleptics (969.6), poisoning, adverse effects and underdosing by cannabis (T40.7), cannabis abuse (305.2 & F12.1), cannabis dependence (304.3 & F12.2), and cannabis use (F12.9).