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# Lessons learned after three years of legalized, recreational marijuana: The Colorado experience

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ABSTRACT

In November 2012 Colorado voters approved legalized recreational marijuana. On January 1, 2014 Colorado became the first state to allow legal sales of non-medical marijuana for adults over the age of 21. Since that time, the state has been monitoring potential impacts on population health. In this paper we present lessons learned in the first three years following legal sales of recreational marijuana. These lessons pertain to health behaviors and health outcomes, as well as to health policy issues. Our intent is to share these lessons with other states as they face the prospect of recreational marijuana legalization.



## 1. Introduction

In November 2012, Colorado became one of the first two states where voters approved legalized recreational marijuana. However, sales did not actually begin until January 1, 2014, when Colorado became the first state to allow legal sales. At that time, with very limited national guidance, Colorado developed a public health framework to monitor, respond to, and prevent population health harms. The details have been outlined previously (Ghosh et al., 2015a). In this paper, we offer lessons learned thus far. These lessons are divided into broad categories on health behaviors, health outcomes, and health policy. Our aim is to assist other states facing legalization.

## 2. Lessons on health behaviors

Data on marijuana use are important for monitoring trends and identifying high risk sub-populations. A lesson for states to consider is adding marijuana questions to population-based surveys prior to major policy shifts, like legalization, with sufficient sample size to monitor regional trends. While the Healthy Kids Colorado Survey of middle and high school students (Colorado's version of the Youth Risk Behavior Surveillance System) has been asking marijuana questions since 1991, Colorado did not add marijuana-related questions to other health behavior surveillance systems until either 2013, just before sales began, or 2014. These included the Behavioral Risk Factor Surveillance System (BRFSS) for adults, the Pregnancy Risk Assessment Monitoring System (PRAMS), and the Child Health Survey (CHS) for parents of young children. The lack of baseline marijuana questions on these surveys makes trend analyses difficult. And while historical data were available on the federally-administered National Survey on Drug Use and Health (NSDUH), the small Colorado sample sizes and resulting modeled state estimates made regional comparisons or comparisons with larger surveys challenging.

Despite the lack of robust, historical data, we have gained insight from information collected thus far. First, we've learned that marijuana use, both among adults and among youth, does not appear to be increasing to date. No change was observed in past 30-day marijuana use among adults between 2014 (13.6%) and 2015 (13.4%) (Colorado Department of Public Health and Environment, 2016a). Similarly,

*Abbreviations:* BRFSS, Behavioral Risk Factor Surveillance System; PRAMS, Pregnancy Risk Assessment Monitoring System; CHS, Child Health Survey; NSDUH, National Survey on Drug Use and Health; ED, Emergency Department; ICD-9, ICD-10, International Classification of Diseases, Ninth and Tenth Revisions; DUI, Driving Under the Influence; THC, Tetrahydrocannabinol.

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there was no statistically significant change in 30-day or lifetime marijuana use among high school students between 2013 (lifetime: 36.9%, 30-day: 19.7%) and 2015 (lifetime: 38.0%, 30-day: 21.2%) (Colorado Department of Public Health and Environment, 2016b). However, youth perception of risk has decreased significantly, with fewer respondents viewing regular marijuana use as risky in 2013 (54.0%) compared to 2015 (48.0%). These trends will be important to continue to monitor (National Research Council (US) and Institute of Medicine (US) Board on Children, Youth, and Families, 2001).

Secondly, we've gained insight on use patterns in various demographics. The highest rates of past 30-day marijuana use were seen among young adults ages 18–25 (26.1%) and high school juniors (26.3%) and seniors (27.8%), with a male preponderance among adult users (16.9% versus 10.0%). We've also learned that people of any age who identified as gay, lesbian, or bisexual were much more likely than heterosexuals to use recently (36.9% versus 12.4% in adults; 34.9% versus 19.5% in youth). There was no clear difference in usage by race/ethnicity among adults, except lower among Asians. Among youth, multiracial students had the highest use (28.0% versus 19.5% among White youth) (Colorado Department of Public Health and Environment, 2016a, b). Data on recently pregnant women also provided insight. Marijuana use before and during pregnancy was highest among women ages 15–24 years (21.1% and 12.8%, respectively). However, marijuana use during the three months before and during the last three months of pregnancy was lower than alcohol and cigarette use during the same periods (Colorado Department of Public Health and Environment, 2016c).

In addition, we've learned about methods of use, frequency, and storage habits. Among adults, smoking was the most common method of use (83.2%), followed by eating (34.4%) and vaping (32.4%). And while the majority of users (among both adults and youth) indicated smoking it, about half also reported using multiple methods (vaping, edibles, dabbing, etc.). Vaping, or vaporizing marijuana, is a method of use in which marijuana vapor, rather than smoke, is inhaled. This is usually done by heating marijuana concentrate in a vaporizing device to a temperature below the point of combustion. Dabbing involves the creation of a highly concentrated form of marijuana, using solvents like butane, that is placed on a heated surface and the resulting smoke is then inhaled. Regarding frequency, nearly half (45.7%) of adults who used in the past 30 days reported using marijuana daily or near daily (≥20 days a month). Approximately one-quarter of high school marijuana users reported daily or near daily use (Colorado Department of Public Health and Environment, 2016a, b). Storage data highlighted that 7.4% of parents reported keeping marijuana in or around the home; of which 73.8% kept marijuana products in a locked container (Colorado Department of Public Health and Environment, 2016d). These data have not only guided educational efforts, but have elevated the promotion of edible safety and safe storage. In addition, they have spurred state-level funding for research on health impacts of less-studied methods of use, like dabbing.

## 3. Lessons on health outcomes

To monitor health outcomes, we examined hospital discharge and Emergency Department (ED) visit data. There were limitations due to variable use of certain International Classification of Diseases, Ninth Revision (ICD-9) codes, and possible changes in coding practices following legalization. Moreover, changes in coding from ICD-9 to ICD-10 make some comparisons difficult. Given these challenges, we detected an increase in hospitalizations with marijuana-related codes by 70% between 2013 and 2015 (CDPHE, 2016). ED visits increased 19% between 2013 and 2014, with a disproportionate increase among tourists, but decreased 27% between 2014 and 2015, to a rate lower than in 2013 (CDPHE, 2016; Kim et al., 2016). However, overall hospitalization and ED visits related to marijuana remain quite small in comparison to alcohol (five times as many alcohol-related ED visits and nearly three times as many hospitalizations) (CDPHE, 2016).

Poison center call data were useful in monitoring unintentional exposures of children, which were predominantly due to edible ingestion. Calls for children 0–8 increased 63% in the first year after legalization, but have been stable since. Poison center calls about adults also increased post-legalization and were predominantly due to intentional use. Approximately half were due to smoked marijuana, and half to edibles (CDPHE, 2016).

State Patrol data for the first 10 months of 2016 show that DUI's where marijuana was noted as an impairing substance were 16% higher than the same period in 2014 (Colorado State Patrol, 2016). Fatalities where the driver tested positive for cannabinoids increased by 80% between 2013 (55) and 2015 (99) (Colorado Department of Transportation, 2016). Of cannabinoid positive incidents, 42% included alcohol in 2013 and 35% in 2015. Changes in testing practices might contribute to these increases. Additionally, fatality data do not indicate whether the driver was impaired or at fault. These limitations highlight the importance of routinely obtaining full toxicology information and matching it to accident, arrest, and fatality data to assess the impact of marijuana-related impaired driving.

Finally, there have been four high profile deaths related to injuries or violence post-edible use (Ghosh et al., 2015a). These have spurred significant policy changes related to edible packaging. However, monitoring for marijuana-related deaths remains challenging. Death certificates listing marijuana do not necessarily indicate that marijuana was causal, and useful surveillance depends on reporting practices by coroners, medical examiners, and law enforcement.

## 4. Lessons in health policy

While Colorado began by incorporating basic lessons from alcohol and tobacco, such as age restrictions, prohibition of public use, and the addition of marijuana to Colorado's Clean Indoor Air Act (Ghosh et al., 2015a), we have also strengthened policy efforts since. For example, while childproof packaging requirements for edibles were established early, the state has since strengthened edible safety regulations, through limitations on maximum THC amounts per single package (Marijuana Enforcement Division & Retail Marijuana Regulations, 2015a), clearly-demarcated servings (Marijuana Enforcement Division & Retail Marijuana Regulations, 2015a), stricter packaging (Marijuana Enforcement Division & Retail Marijuana Regulations, 2015b), required universal symbols on labels (Marijuana Enforcement Division & Retail Marijuana Regulations, 2016), and restrictions on products that may be enticing to children (Marijuana Enforcement Division & Retail Marijuana Regulations, 2015c; Colorado House Bill 1436, 2016).

Another state policy decision was to invest marijuana tax revenue in social market research, to maximize health messaging impacts. Through this research, Colorado found distinct attitudes about marijuana use among English and Spanish speakers, users and non-users, and older and younger populations (Colorado Department of Public Health and Environment, 2015). These data have enabled the development of messaging that resonates with varying audiences. Colorado developed a general campaign on awareness of marijuana laws which had nearly 170 million media impressions within nine months (Colorado Department of Public Health and Environment, 2016e). Evaluation data indicated that knowledge of key laws was 2.5 times higher among adults exposed to this campaign (Brooks-Russell et al., 2016). Additionally, we launched a campaign focused on youth, which has had >23.5 million media impressions in the last five months (Colorado Department of Public Health and Environment, 2016f), and one for trusted adults in the lives of youth, with 11.5 million media impressions in a similar timeframe (Colorado Department of Public Health and Environment, 2016g). Furthermore, Colorado has a campaign targeting pregnant and breastfeeding women which has generated >4

million impressions in its first five months (Colorado Department of Public Health and Environment, 2016h).

Another policy lesson relates to laboratory testing. Validating that laboratories are accurately testing for cannabinoid concentrations, residual solvents, and contaminants is very important to public health, but testing must be done in-state due to federal restrictions. Identifying appropriate pesticide and microbial contaminants, and corresponding action levels, has been challenging given the multiple methods of use for marijuana and the lack of toxicity threshold data. When developing regulations, testing requirements should be easily changeable to accommodate emerging scientific data. Furthermore, because standard marijuana test methods do not exist, allowable methodologies should be based on relevant methodologies from other industries and rigorously validated. From a policy perspective, states should consider establishing a reference laboratory and proficiency testing processes to ensure inter-laboratory reliability.

Finally, a major lesson learned relates to the alignment of medical and non-medical marijuana regulations. In Colorado, medical marijuana was legalized years before recreational. This led to discrepancies in taxation, allowable possession amounts, testing requirements, labeling/packaging, and other areas. Through legislation, many of these issues have now been addressed. However, we encourage states to proactively align regulations early on, to avoid potential confusion (Ghosh et al., 2015b).

## 5. Conclusion

In the three years since legal recreational marijuana sales began, Colorado has learned many lessons. Strong surveillance systems, both for health behaviors and outcomes, and a readily adaptable approach to health policy, are key components to a public health response to this emerging issue.

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## Transparency document

The Transparency document associated with this article can be found, in online version.

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