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Research Paper

Cannabis and youth protection in Colorado's commercial adult-use market: A qualitative investigation

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ABSTRACT

Introduction: Arguments both for and against the legalization of cannabis often include the issue of youth protection. At the time of writing 5-years after the implementation of the Coloradan recreational cannabis market (CRCM), no statistically significant increase in consumption had been identified. This paper aimed to provide a thick descriptive account of youth prevention objectives stipulated in the pre-implementation phase of the CRCM and compare these with the real-world experience of regulators and other stakeholders involved with market implementation.

Methodology and Methods: A qualitative descriptive methodology was used that involved the following methods: document analysis, deductive coding, thematic analysis, and thick description. Two data sets relevant to youth protection in the context of a legal cannabis market in Colorado were examined. Data set 1 (DS1) examined government documents (n = 13) related to the pre-implementation phase from November 2012 - December 2013. Data set 2 (DS2) consisted of semi-structured face-to-face interviews conducted with key stakeholders (n = 32) in 2016 and 2017.

Results: Five themes emerged including advertising restrictions (DS1), education (DS1), appropriation of funds (DS2), impact assessment (DS2), and evolving messages in prevention education campaigns (DS2).

Discussion: Multiple lessons for other jurisdictions were highlighted in the study.

Introduction

Arguments both for and against the legalization of cannabis often mention the issue of youth protection. Those who view the prohibition of cannabis as the best way to protect youth from risks associated with the early initiation of consumption tend to argue that legalization of the drug will result in wider availability and greater risk of exposure for adolescents, ultimately increasing usage in this important cohort (Caulkins et al., 2015). By comparison, advocates for regulated cannabis models generally contend that youth are already widely exposed to the drug and are best protected by regulating the availability of cannabis products, and also argue that part of tax revenue generated can be directed toward funding targeted youth prevention and education programs (Drug Policy Alliance, 2019a).

An oft-stated perceived advantage of commercial models of cannabis regulation is that they are the most likely to maximize revenue generation for the State, which can then be appropriated to public health initiatives such as youth prevention education campaigns (Caulkins et al., 2015; Caulkins, Kilmer & Kleiman, 2016; Rolles & Murkin, 2016). Indeed Caulkins et al. (2015) argued that departments of revenue may even prioritise revenue generation over public health goals. Conversely, the risks of youth exposure are thought to be amplified in commercial markets where prices were expected to (and did) decline (Marijuana Policy Group, 2018; Subritzky, Lenton & Pettigrew, 2019, 2016). According to Gravelle and Lowry (2014), the elasticity of demand among youth is greater than for adult cannabis consumers generally, which implies that price is an important element in youth consumption decisions. In addition, according to Pacula, Kilmer, Wagenaar, Chaloupka and Caulkins (2014, p.1022), "hundreds of studies on alcohol and tobacco show that raising prices reduces consumption and a long list of related health and social harms".

Five years after the State became the first jurisdiction worldwide to implement a fully regulated seed-to-sale recreational cannabis market in 2014, important practical lessons can be learned from the Coloradan experience. It is important to note that even with the introduction of the CRCM, cannabis remained prohibited for recreational use for those under the age of 21 and 18 for medical cannabis. In this sense, at least legally, prohibition laws have not changed for young people in the State.

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The paper focuses on the theme of youth protection in the context of a legal, commercial distribution model of cannabis in Colorado. It reports the outcomes of an analysis of a sample of government documents from the pre-implementation phase of the CRCM (November 2012 - December 2013) and semi-structured interviews were conducted in 2016 and 2017 with 32 key stakeholders intimately involved in the initial development of the Retail Marijuana Code (RMC) in Colorado.

The following subsections of this Introduction address: (i) risks associated with early initiation of cannabis consumption are reviewed; (ii) age restrictions and a range of prevention messaging approaches are described; (iii) the evolution of Coloradan prevention campaigns is laid out; and (iv) latest youth consumption statistics from national, state, and local surveys are examined.

The Results section includes two main sections that report on the analysis of both the government documents and interviews data sets. In the government documents data set, the themes of retail advertising restrictions and education emerged from the analysis. Three themes emerged from the interviews data set: when funds should be appropriated; impact assessment (including the issues of changes to school data and methodological considerations); and evolving messages in prevention education campaigns. The Discussion includes a comparison of the two data sets and lessons and recommendations for other jurisdictions considering cannabis policy reform.

Higher risks associated with early initiation

According to Szabo (2014, p.700), "the epidemiological evidence on cannabis dependence and adverse effects on cognitive performance and poorer educational outcomes provide good reasons for reducing cannabis-related harm among adolescents". Additionally, Fischer et al. (2017) did a systematic review that searched for harmful cannabis consumption, identified a multitude of studies highlighting elevated risks associated with early initiation of consumption (i.e. under the age of 21 unless otherwise stated). For example, evidence suggests that the initiation of cannabis consumption under 18 increases the risk of dependence to 1 in 6 (approximately 16.5%) (Anthony, 2006; Szabo, 2014), which compares to dependence rates of 9% for people who have ever consumed cannabis and around 2% of the general population (Room, Fischer, Hall, Lenton & Reuter, 2010).

As has been noted by several scholars, the brain is still developing until at least the age of 21 (e.g. Gogtay et al., 2004), and potentially up to 25 (Szabo, 2014). Thus, prenatal and adolescent exposure to "environmental insults" such as THC are particularly concerning (Volkow, Baler, Compton & Weiss, 2014, p.2220). Further, regular consumption of cannabis in adolescence has been associated with impaired neural connectivity in regions of the brain involved with alertness, memory, and learning, compared with control groups (Batalla et al., 2013; Filbey & Yezhuvath, 2013; Zalesky et al., 2012). These risks are thought to be magnified by an adolescent's high number of days of use and high amounts used per day (Caulkins et al., 2015; James, James & Thwaites, 2013; Lisdahl, 2013).

Age restrictions and prevention messaging

Age restrictions are seen as an important control on limiting youth access to cannabis (Rolles & Murkin, 2016). However, finding the right balance is critical – if the age is too high then a black market may be incentivized, while if it is too low there may be increased risk of higher consumption rates (Rolles & Murkin, 2016). In addition, age restriction effectiveness depends on enforcement levels (Rolles & Murkin, 2016). Media coverage of industry compliance based on mandatory state government annual reports indicated that recreational cannabis stores in Colorado prevented 95% of underage purchases, similar to alcohol (89%) and tobacco stores (94%) (CBS Denver, 2018, May 25; Colorado Department of Revenue Marijuana Enforcement Division, 2017).

Rolles and Murkin (2016)) pointed out the need for age restrictions to be supported with prevention education and evidenced-based harm reduction programs. How cannabis prevention messages are framed is an important public health consideration. A legalized cannabis market may, by its existence, send confused messages with youth potentially assuming cannabis to be safe if it is available for sale, particularly if it is also a legal medicine, and prevention programs and messages might have to change in legal cannabis contexts (Caulkins et al., 2015). Kilmer (2014, p.2) has argued that "even the best [drug] prevention programs are not particularly effective", however real-world evidence on the effectiveness of youth prevention/harm reduction education campaigns in legal commercial cannabis markets is thin. Investigating the Coloradan experience can begin to address this evidence deficit.

Several stakeholders proposed that with the right information, youth will make good choices around cannabis consumption. For example, in discussing an education campaign in the City of Denver, Mayor Hancock reportedly stated: "Teens want facts and they want to be able to make their own decisions. When we give teens the facts and equip them with knowledge, they make smarter choices about using marijuana" (Marijuana Moments, 2019, Mar. 19). The same contention was made by the National Institue on Drug Abuse (2019). Where they seem to differ is on what the facts are and how they should be presented. Traditionally, prevention messaging has tended to focus on abstinence-only programs such as the 'just say no' campaigns of the 1980s and Drug Abuse Resistance Education (2019), while more recently there has been an increase in harm reduction focused messaging (e.g. Drug Policy Alliance, 2019b).

Evolution of Colorado's prevention education messaging

The retail marijuana education program logic model developed by the Colorado Department of Public Health and Environment (2014) provided a high-level overview of the strategy undertaken by the State. According to Ghosh et al. (2016), central aims of the model included the protection of vulnerable populations such as youth and data collection for impact assessment. Both the Colorado Department of Public Health and Environment (2019a) and the Colorado Office of Behavioral Health (2019) have developed comprehensive cannabis prevention messaging resources for communities, together with detailed annual reports (e.g. Colorado Department of Public Health and Environment, 2017).

At time of writing, Marijuana Tax Fund appropriations to prevention education had increased significantly since initial implementation of the CRCM (Colorado Office of State Planning & Budgeting, 2017). In Colorado there have been at least three state-run prevention campaigns since 2014 including: (i) 'Don't be a lab rat'; (ii) 'protect what's next'; and (iii) 'responsibility grows here' (Colorado Department of Public Health and Environment, 2017, 2019b, 2019c). In addition, local jurisdictions such as City of Denver (2019b) have implemented their own prevention education programs.

National, state, and local data indicate no increase in consumption among youth

It was widely predicted that the implementation of a commercial adult-use cannabis market in Colorado would lead to higher rates of consumption among youth (e.g. Caulkins et al., 2015), however early evidence has not supported this contention, with recent data reporting 'encouraging trends' (Colorado Department of Public Health and Environment, 2018). For example, five years after the implementation of the CRCM, latest data indicate no statistically significant increase in youth consumption patterns with multiple data sets finding that, while perception of cannabis harmfulness has markedly decreased among adolescents in Colorado, an associated effect of increased consumption

has not been identified, with similar usage rates to pre-legalization (Brooks-Russell et al., 2019, 2018; Colorado Department of Public Safety Division of Criminal Justice, 2018) .[1] These data are similar to survey findings from previous studies that first began to accrue in late 2015 in the form of national survey results such as Substance Abuse and Mental Health Services Administration (SAMHSA) (Hughes, Lipari & Williams, 2015) and Monitoring The Future (MTF) (Johnston, O'Malley, Miech, Bachman & Schulenberg, 2015).

In the City of Denver, there is evidence from a small survey of 500 participants that consumption rates among youth had dropped to below the national average for the first time in decades (City of Denver, 2019a). These results reportedly led Denver Mayor Hancock to declare that prevention education programs in the jurisdiction have been "a success" (Marijuana Moments, 2019, Mar. 19).

Critique of data collection methodologies

It has been argued that in the US generally, data systems for measurement of the quantity of cannabis consumed, as opposed to prevalence of use, are insufficient (Caulkins et al., 2016; Kilmer, 2015, November 25). The potential for bias in self-report surveys, confounding due to some people being? excluded from the sampling frame, and shortcomings of existing survey instruments were also noted (Ghosh et al., 2015; Kilmer, 2015, November 25). Thus it may be years or decades before the consequences of newly legalized commercial marijuana markets, such as that in Colorado, are revealed (Pacula & Sevigny, 2014). In specific regard to Colorado data collection instruments, Ghosh et al. (2015) provided a timely overview of measures implemented to monitor prevalence of use, public health effects, and challenges associated with assessment. They noted that a problem with using the existing population-based surveys was that they did not include validated questions addressing issues such as variation in methods of marijuana consumption, home storage, cultivation, and intoxication.

Methodology and methods

The issue of interest in this paper was youth protection in the context of a legal commercial cannabis market in Colorado, with a focus on desired objectives compared with real-world policy implementation. In this regard, the paper incorporates a qualitative descriptive methodology to examine the issue following Sandelowski (2000) and following Braun and Clarke (2006) in employing thematic analysis across the data corpus rather than simply within individual items.

Two data sets were included in the present study for comparison, namely government documents relating to the pre-implementation phase (circa Dec. 2012 – Dec. 2013) and semi-structured interviews with key Coloradan stakeholders in 2016 and 2017. The government documents (n = 13) were collected via targeted searches of the Official Colorado Web Portal, which houses publicly available records for relevant government departments. Other sources of documents including public online records of the Colorado Secretary of State and the Colorado State Legislature (General Assembly) were reviewed to identify documents to include in the analysis.

Interviewees were selected purposively via convenience and snowball sampling techniques (Liamputtong, 2013; Weiss, 1995). Potential interviewees were identified during the analysis of government documents, which allowed for direct recruitment via email. Other interviewees were recruited at policy symposiums and trade shows in Colorado. Additionally, Professor Beau Kilmer, a US-based cannabis policy scholar, provided introduction letters to several senior regulators involved with implementing the CRCM. Snowballing was used to expand the list of potential interviewees using participant's relevant networks. Following Janghorban, Roudsari and Taghipour (2014), no distinction was made whether the face-to face interviews were conducted in the same physical space or by Skype. Detailed narrative and tabular overviews of the two data sets are provided in the respective sub-sections of the Results below.

The present study incorporated numerous methods including document analysis (Bowen, 2009), thematic analysis employing deductive coding (Braun & Clarke, 2006), and thick description (Creswell & Miller, 2000). Ethics approval was granted by the Curtin University Human Research Ethics Committee (approval HRE2016-0230). In all extracts used in this paper, permission to name interviewees was obtained from participants.

Results

Data set 1: government documents – pre-implementation phase November 2012 – December 2013

Summary of data set 1

The data set included the following documents types: Legislative Bills (n = 4), Governor Executive Orders (n = 2), a federal memorandum (n = 1), Task Force and General Assembly reports (n = 2), a Constitutional Amendment (n = 1), and Codes of Regulations (n = 3). See Table 1 below for full details of documents by date, title, number of pages, and document type.) .[2]

Youth protection

A key objective stated in most government documents (n = 11) under investigation was the protection of youth and this issue emerged in the sample across multiple stages of the pre-implementation phase of the CRCM. In general, the documents highlighted the importance of youth protection and designated specific responsibilities in this regard to the Colorado Departments of Public Health and Environment and Human Services. For example, text in A64 was explicit about youth protection and continued prohibition for those under 21 years of age:

> Marijuana should be legal for persons twenty-one of age or over …
>
> Nothing in this section is intended to … allow a person under the age of twenty-one to purchase, possess, use, transport, grow or consume marijuana
>
> Individuals will have to show proof of age before purchasing marijuana
>
> **A64, P.1**

While this text clearly articulated rules intended for the CRCM, it did not differentiate it from the existing medical market. Thus, an immediate complication related to the 18-year age limit for medical cannabis, which is problematic for assessing the impact of the retail scheme, as well as confusion around how "youth" is defined. Those between the ages of 18 and 21 would be required to join the patient registry by obtaining a doctor's certificate and applying for a red card, should they wish to legally consume cannabis. Failure to do so could result in a minor in possession charge, counseling, and community service as was stipulated in SB13-283, which highlighted the continued prohibition of recreational cannabis for those under 21.

The A64 Task Force listed several recommendations in their report regarding the matter. Notably, the report suggested on-going training for youth-focused professionals relating to cannabis impairment,

[1] Both Professor Brooks-Russell and the Colorado Department of Public Safety statistician were interview participants in this study.

[2] Summaries of these documents are provided in the appendix of (Subritzky, in preparation).

Table 1
Overview of pre-implementation documents related to the recreational cannabis market in Colorado: November 2012 – December 2013.

Document ID	Date	Document title	Pages	Document type
A64	Nov. 6, 2012	Amendment 64: Article XVIII, Section 16: Personal Use and Regulation of Marijuana, Colorado Constitution.	12	Initiated constitutional amendment
EO B2012-004	Dec. 10, 2012	Governor's Executive Order B2012-004: Creating a Task Force on the implementation of A64.	4	Governor's Executive Order
A64 Task Force Report	*Dec. 17, 2012 -Feb. 28, 2013	Task Force Report on the Implementation of Amendment 64: Regulation of Marijuana in Colorado.	165	Task Force Report
GA Report	*Mar. 7, 2013 – Apr. 8, 2013	Joint Select Committee Report on the Implementation of the Amendment 64 Task Force Recommendations.	6	General Assembly Report
HB 13–1317	May 28, 2013	House Bill 13–1317 Implement A64 Majority Recommendation.	73	Legislative Bill
HB 13–1318	May 28, 2013	House Bill 13–1318 Retail Marijuana Taxes.	19	Legislative Bill
SB 13–283	May 28, 2013	Senate Bill 13–283 Implement A64 Consensus Recommendations.	16	Legislative Bill
HB 13–1325	May 28, 2013	House Bill 13–1325 Inferences For Marijuana And Driving Offences.	18	Legislative Bill
EO D2013-007	Jun. 11, 2013	Governor's Executive Order D2013-007: Directing state agencies to implement Senate Bill 13–283.	2	Governor's Executive Order
RMC 2013 (Temp)	Jun. 28, 2013	Retail Marijuana Code 1 CCR 212–2 (Emergency Rules).	70	Code of Regulations (Retail cannabis)
Cole Memo	Aug. 29, 2013	Cole Memo: Guidance Regarding Marijuana Enforcement.	4	Federal Memorandum (Department of Justice)
RMC 2013 (Perm)	Sep. 9, 2013	Retail Marijuana Code: 1 CCR 212–2 (Updated Permanent Rules).	136	Code of Regulations (Retail cannabis)
MMC 2013 (Perm)	Oct. 15, 2013	Sales, Manufacturing, and Dispensing of Medical Marijuana: 1 CCR 212–1 (Updated Permanent Rules).	88	Code of Regulations (Medical cannabis)

* Denotes time period during which participant meetings took place to develop reports as opposed to publication date.

paraphernalia, risks, and ongoing development of materials aimed at preventing youth from consuming cannabis. For example:

> K – 12 educators/ counsellors; Colorado Education Association and Colorado Department of Education; prevention specialists; university staff, Colorado Commission on Higher Education; Child Welfare Services, Colorado Department of Human Services.
>
> …
>
> *Marijuana use prevention for those under age 21… Target markets include parents, students, and educators… Materials can include websites, brochures, billboards, public service announcements, etc.* **A64 Task Force Report, P.153 – 154.**

Retail advertising restrictions

A major public health concern regarding commercial cannabis markets is that advertising and promotion may disproportionately impact vulnerable segments of the population such as youth and people with problematic cannabis use. The issue of retail advertising restrictions emerged from six documents within the context of youth protection including A64, A64 Task Force Report, HB 13–1317, RMC 2013 (Temp), RMC 2013 (Perm), and MMC 2013 (Perm), all of which indicated that the protection of youth was a high priority. The following justification for advertising restrictions is representative:

> *Amendment 64 allows for legal access to and use of marijuana only for adults over 21 years of age. As such, and to protect the health, safety, and well-being of youth, marketing and advertising of marijuana products and accessories should be carefully regulated to avoid reaching persons under 21 years of age.* **A64 Task Force Report, p.53–54**

The extent to which advertising restrictions should be applied was apparently open to some debate. In the end, a rule stipulating 30% likelihood of being seen by minors as the acceptable standard in line with restrictions on the promotion of alcohol in the State was incorporated, which was itself rather arbitrary and difficult to define. The following text provides both an indication of the process of how the advertising rules were consolidated at the final stage of the rulemaking process and justification for the decisions made by the Colorado Department of Revenue (CDOR):

> The [CDOR] received extensive comments reflecting the strong influence advertising has on minors' decision-making with regard to substance use and abuse.
>
> Nearly all live testimony at the rulemaking hearing requested less restrictive advertising rules, but written commentary included multiple perspectives. The written and oral testimony and commentary included a variety of recommended standards for determining when advertising has a high likelihood of reaching minors.
>
> Voluntary standards adopted by the alcohol industry direct the industry to refrain from advertising where more than approximately 30 percent of the audience is reasonably expected to be under the age of 21. After reviewing the rulemaking record, the [CDOR] has determined … it is appropriate to model the retail marijuana advertising restrictions on this voluntary standard used by the alcohol industry.
>
> This standard is consistent with the directive in the state constitution [A64] to regulate marijuana in a manner that is similar to alcohol, while also recognizing that the legal status of the marijuana industry and the legal status of the liquor industry are not the same.
>
> *The [CDOR] will continue to evaluate the best way to … establish appropriate advertising restrictions for this emerging industry, and will in particular continue to monitor and evaluate advertising, marketing and*

Table 2
Overview of advertising restrictions in the RMC 2013.

Series ID	Series name
R 1102	No false or misleading statements
R 1104	TV (30% rule)
R 1105	Radio (30% rule)
R 1106	Print media (30% rule)
R 1107	Internet (30% rule)
R 1108	Targeting out of state people prohibited
R 1109	Signage and advertising
R 1111	Signage and outdoor (local ordinances) + generally prohibited
R 1112	Not target minors
R 1113	Mobile devices
R 1114	Pop up advertising
R 1115	Event sponsorship – ok, event advertising (30% rule)

RMC 2013 (Perm) P.107 - 117.

> *signage to protect the interests of those under the age of 21 and to prevent underage use of marijuana.* **RMC 2013 (Perm), P.107 - 108)**

The above text offers insights into the advertising rules stipulated in the RMC 2013 (Perm). Restrictions are clearly focused on shielding youth, which is a consistent thread in all relevant documents for this section. Furthermore, restrictions placed on regulators by A64 (highlighted in the text) prevent some public health best practice from being deployed (e.g. zero advertising). This aspect highlights the point that from a public health perspective, it may be better for cannabis reform to be driven by regulators as opposed to direct democracy initiatives, particularly if those initiatives are constitutionally enshrined as is the case (uniquely) in Colorado.

The statement that the CDOR will continue to evaluate advertising restrictions seems to be an indication that the recreational rules were not finalized in the pre-implementation phase, but rather they constituted an initial framework that could be modified within the Coloradan rulemaking process as and when issues and unintended consequences arise. Table 2 below lists the different sections of the advertising regulations in the RMC 2013. While not reaching optimal levels of public health best practice regarding cannabis advertising, the initial restrictions in the CRCM were reasonably comprehensive.

Education

In the Introduction it was pointed out that cannabis prevention education is an important public health intervention. Content relating to education was identified in five of the documents, including both Governor executive orders, the A64 Task Force Report, the GA Report, and SB 13–13,283 (which related to issues that received consensus approval from the A64 Task Force Report). In general, the references indicate an intention to implement programs as opposed to actual implementation. The following extracts are representative:

> The Office of the Governor, in consultation with the CDHS, the CDPHE, the CDPS and other state agencies deemed appropriate … shall establish a marijuana educational oversight committee composed of members with relevant experience in marijuana issues. This marijuana oversight committee shall develop and implement recommendations for the education of all necessary stakeholders on issues related to marijuana use, cultivation, and other relevant issues. Further, if this committee finds it appropriate, it shall encourage professions to encourage marijuana education as part of continuing education programs.

> *The Office of the Governor, in consultation with the CDHS, the CDPHE, the CDPS and other state agencies as deemed necessary shall develop and deploy education materials regarding appropriate retail marijuana use, the prevention of marijuana use by those under twenty-one years of age, and materials to discourage driving while under the influence of marijuana. The Office of the Governor will utilise established best practices, existing federal and state resources and innovative tools in developing and deploying these educational materials.* **EO D2013-007, June 11 2013, p.2**

> *The division is not required to perform the duties required by this section until the Marijuana Cash Fund … has received sufficient revenue to fully fund the appropriations made to the CDOR, and the General Assembly has appropriated sufficient moneys for the fund for such duties.* **SB 13–283, May 28, 2013, p.8**

These extracts appear to highlight the importance of youth prevention initiatives that were to be implemented alongside cannabis legalization. For example, it is apparent that government agencies such as CDHS, CDPHE, and CDPS that have skills and experience relevant to protecting youth from cannabis were tasked with developing youth prevention education programs. Crucially, however, the text also identifies a lag of at least two years before implementation of the prevention programs, as they were not to be undertaken until sufficient revenue had been appropriated from the Marijuana Tax Fund. This timing around when funds were appropriated for youth prevention campaigns is discussed in more detail in the analysis of the interview data below.

Data set 2: interviews – post-implementation

Summary of data set 2

Table 3 below provides an overview of semi-structured interviews conducted with a group of key stakeholders (n = 32) in 2016 and 2017 in Colorado. The participants largely consisted of executive director or senior management level administrators from State and local government departments, the cannabis industry, and public health organizations who were intimately involved in the initial development of the RMC in Colorado (roles stated in Table 3 are from time of interview). In total, 27 face-to-face interviews were conducted including individual (n = 19), group (n = 3), and individual Skype (n = 5) interviews totaling 946 min (approximately 16 h). One participant, Barbara Brohl, the Executive Director of the CDOR, was interviewed twice in two different group interviews. The majority of interviewees (n = 24) participated in the rulemaking process – defined in this paper as official involvement in either the Governor's A64 Taskforce, specialist working groups, or scientific advisory boards. Additional participation in rulemaking, such as via open public hearings or informal work group meetings by interviewees, was not stipulated. Three participants included in the data set were California-based, and while they had knowledge of the legal cannabis markets in the US generally, they did not address rules specific to Colorado. Most interviews took place in Denver, with exceptions being those conducted in Aspen, Pueblo, Boulder, Colorado Springs, and San Francisco, and those conducted via Skype.

The topic of youth protection was discussed in just under a third of the interviews (n = 8) and broadly encompassed three themes: (i) late appropriation of funding (n = 5); (ii) impact assessment (n = 4); and (iii) evolution of prevention messaging campaigns (n = 3).

Appropriation of funds: not if but when

While there were examples in the interviews of the CDOR strategizing to increase revenues (in line a key objective stipulated in multiple pre-implementation documents to 'establish a reliable funding mechanism'), there was no indication that public health objectives were compromised as a result. Rather, multiple interviewees (n = 5) indicated that the major challenge associated with funding in the CRCM related not to how or who is funded, but when. In general, interviewees discussing this perspective contended that a lack of prefunding hindered the initial implementation of public health objectives stipulated

Table 3
Overview of interviews and interviewees.

Date	Interviewee	Role	Interview length (mins)	Regulatory participant	Interview Type	Comment
Nov. 2016	Jorge Cervantes	Cannabis Cultivation Author	12	N	I	World-renowned cannabis cultivation author. California based.
Nov. 2016	Barbara Brohl*	Executive Director: CDOR	52	Y	G	Participant: A64 Taskforce and multiple work groups.
Nov. 2016	Jim Burrack	Director: MED	52	Y	G	Participant: A64 Taskforce and multiple work groups.
Nov. 2016	Ean Seeb	Industry Pioneer and Lobbyist	27	Y	I	Sold original dispensary to Willie Nelson. Former Chairman of NCIA (largest cannabis industry lobby in US). Participant: multiple work groups.
Nov. 2016	Seth Wong	President: TEQ Analytical Labs	32	Y	G	First ISO certified cannabis testing lab in Colorado. Member: Colorado Lab Council and Colorado Leads (a coalition of cannabis business leaders). Participant: multiple work groups.
Nov. 2016	Eric Ritvo	Business Expansion Manager: TEQ Analytical Labs	32	N	G	
Nov. 2016	Andrew Freedman	Director: OMC (Governor's Office)	27	Y	I	Participant: A64 Taskforce and multiple work groups.
May 2017	Commercial Grow Manager	Cannabis Cultivation Facility Manager	27	N	I	Medium sized facility (Tier 2). Did not give consent to be named in interview.
May 2017	Dr Patricia Winters MD	Medical Marijuana Doctor	10	N	I	California. Mentored by well-known Harvard Professor and cannabis scholar Lester Grinspoon.
May 2017	Dr Larry Wolk, MD	Executive Director: CDPHE	27	Y	I	Participant: A64 Taskforce and multiple work groups.
May 2017	Hillary Keisar	Analytical Chemist Pharm Labs	19	N	I	California firm.
May 2017	Yogi D	Author and Founder of 420 Yoga Retreats. Cannabis Yogi	35	N	I	Named America's relaxation expert on CNN. Bestselling author.
May 2017	Lexie Potamkin	Philanthropist and Cannabis Youth Education Provider	32	N	I	
May 2017	Maureen McNamara	Founder & Chief Facilitator: Cannabis Trainers	29	Y	S	Participant: responsible vendor work group.
May 2017	Mitch Yergert	Director: CDA	30	Y	I	Participant: multiple work groups.
May 2017	Ryan Medina	Cultivation Manager	27	N	I	Medium sized facility (Tier 2).
May 2017	Dan Banks	Founder: Next Generation IPM	40	Y	I	Participant: pesticide work group.
May 2017	Stephen Goldman, PhD	Lab Director: Phytatech Labs	36	Y	I	Member: Colorado Lab Council. Participant: multiple work groups.
May 2017	Lee Maloy	Co-Founder: International Church of Cannabis	8	N	I	An 'elevationist'.
May 2017	Industry Executive	CEO: large, vertically integrated, end to end cannabis firm	20	Y	I	Did not give consent to be named in interview. Participant: multiple work groups.
May 2017	Shawn Kasseur	Senior Scientist: Neptune & Company	45	Y	I	Participant: multiple work groups.
May 2017	Jack Reed	Statistical Analyst: CDPS	80	Y	I	Participant: multiple work groups.
May 2017	Sam Kamin, PhD	Vicente Sederberg Professor: Marijuana Law and Policy, University of Denver	20	Y	I	Participant: A64 Taskforce and multiple work groups.
May 2017	Barbara Brohl*	Executive Director: CDOR	50	Y	G	Participant: A64 Taskforce and multiple work groups.
May 2017	Ron Kammerzell	Senior Director: MED	50	Y	G	Participant: A64 Taskforce and multiple work groups.
May 2017	Mathew Scott	Senior Director: CDT	50	Y	G	Participant: multiple work groups.
May 2017	Heidi Humphreys	Deputy Director: CDOR	50	Y	G	Participant: multiple work groups.
May 2017	Ashley Brooks-Russell, PHD	Assistant Professor: UC Denver. Project Director: Healthy Kids Colorado Survey	24	Y	I	Member: Colorado Retail Marijuana Public Health Advisory Committee. Participant: A64 Taskforce and multiple work groups.
May 2017	Heath Harmon	Director: Health Programs at Boulder County	54	Y	S	Member: City of Boulder Marijuana Advisory Panel and Colorado Retail Marijuana Public Health Advisory Committee. Participant: A64 Taskforce and multiple work groups.
May 2017	Steve Baugh	Cannabis Chemist and Educator	60	Y	S	Participant: testing licensee work group.
May 2017	Colin Bell, PhD	Cofounder and Chief Growth Officer: Growcentia	48	Y	S	Participant: multiple work groups.
May 2017	Dr Ken Finn, MD	Pain Medicine Physician	75	Y	S	Member: Colorado Medical Marijuana Scientific Advisory Council. Participant: A64 Taskforce and multiple work groups.

Key: *Interviewed twice; *I* = Individual; *G* = Group; *S* = Skype.
Acronyms: CDOR = Colorado Department of Revenue; MED = Marijuana Enforcement Division; CDPHE = Colorado Department of Public Health and Environment; CDA = Colorado Department of Agriculture; CDT = Colorado Department of Taxation; CDPS = Colorado Department of Public Safety; OMC = Office of Marijuana Coordination (Governor's Office); MPG = Marijuana Policy Group; IPM = Independent Pest Management.

in the A64 Taskforce Report[3] (including data collection for impact assessment) and prevention education campaigns for youth.

The statement below by the Executive Director of the CDOR is representative of interviewee responses on the issue. She noted that an initial decision was made that cannabis-related expenses would be self-funded through tax revenues generated from sales. The logic behind this was reportedly that it was not appropriate for cannabis-related policy funds to be drawn from the State's general account.

> It was decided that the regulation of recreational marijuana should be self-funded – that just seemed like the appropriate position to take from the outset. The Marijuana Enforcement Division (MED) gets first bite at the apple and so *does the tax division. We get what's called same year appropriation. So the same year that this comes in we get to spend it. And then after that the next year it really goes to things like youth prevention, substance abuse prevention, treatment, and impact assessment.* **Group Interview: Barbara Brohl - Executive Director CDOR (speaker), Ron Kammerzell - Senior Director of Marijuana Enforcement Division, Mathew Scott - Senior Director of Taxation, Heidi Humphreys - Deputy Director CDOR, May 2017, Denver.**

This extract highlights an important lesson that may need consideration by regulators in jurisdictions legalizing cannabis, namely *when* revenue is appropriated. This issue is revisited in the discussion below.

Impact assessment

In interviews where impact assessment was discussed in the context of youth consumption ($n = 4$), the following topics were discussed: (i) no increase in youth consumption, although it remained too early to make definitive judgments (as this issue is largely reflected in the consumption statistics presented above, it is not discussed further in this section); (ii) changes to school data collection; and (iii) methodological considerations.

Changes to how school data are recorded

One element of the issue of impact assessment that emerged from the interviews related to the necessity of changing how cannabis-related drug expulsion data were recorded, and that such change reportedly needed to be considered in the context of broader changes to education policy in the state. According to the State's senior cannabis impact statistician:

> Prior to the last school year the 2015/2016 school year, when they were collecting information on school discipline so suspensions, expulsions, law enforcement they had the category of drugs. We trended on that for a decade but it's only drugs. And anecdotally they would say yeah it's mostly marijuana but they couldn't actually tell you it's 20%, it's 80% its 90%. In the last school year they actually broke marijuana out separately and so we were able to get a sense of okay 60% of expulsions for drugs are for marijuana 80% percent of suspensions that are for drugs are for marijuana.
>
> The other issue that occurred right around the time where we voted on legalization was the Department of Education really started pushing schools to use other types of discipline rather than suspension or expulsion because suspensions and expulsions have long term impacts on kids' outcomes. So graduation, good college, getting a decent job all those things are impacted by getting expelled when you are in 8th grade it can be a persistent effect.
>
> *And so they really worked with the schools and there was a lot of paths that really tried to minimize suspensions and expulsions. So what you find with drug expulsion, drug expulsions have gone down. They went down because of a change in policy. There was a state-wide change of policy. So that's one of those things where there's various variables … that has nothing to do with drug legalization or marijuana legalization. It has everything to do with policy surrounding suspension and expulsions.* **Jack Reed, Statistical Analyst, CDPS, May 2017**

From this extract it is apparent that how drug consumption data were recorded in schools was changed to include cannabis specific data. The multi-faceted nature of cannabis policy and how at times impact data may be influenced by broader policy changes were also highlighted.

Methodological considerations

In the Introduction section, critiques of cannabis data collection instruments in the US generally were presented, and these were addressed in an interview with the Director of the Healthy Kids Colorado Survey. First, the gap pertaining to prevalence data (as opposed to frequency data) was discussed:

> *Yes, what we commonly report is the proportion of students who say they've used at all in the last 30 days. So what's getting masked there is the distribution of the frequency of use within the 30 days. So, how many daily users. We know that too. We just don't use that as an indicator. What we see is this kind of bimodal thing where we got a chunk of kids who are using once or twice in a month in our snapshot and then a chunk of kids who are using 20 times or more in a month and not that many in the middle. So we have kind of heavy users and not heavy users and we don't know what they're using or all the times the user uses in a day we don't know. Is it one joint or is it 5 joints?* **Ashley Brooks-Russell, PHD - Assistant Professor UC Denver. Project Director Healthy Kids Colorado Survey, Denver, May 2017**

From a public health and/or harm reduction perspective, this nuanced approach to identifying the highest risk consumption patterns is desirable. As more datapoints accrue it is likely this gap will be filled in coming years. In addition to these limitations, there was also a methodological critique of self-report data collection, namely that the HKC data may lack reliability due to the reliance on self-report. In response to this criticism that self-report data was potentially open to false reporting, the HKC survey project leader provided a robust defense of the methodology noting that this was merely one datapoint and needed to be considered together with other data from different surveys with different methodologies.

> We have been struggling with that critique and other kind of methodological critiques of our survey effort coming out of advocate organizations out of Florida, Project Sam and it's very frustrating to me. What I would say is a couple of things. First of all, I don't think self-reported data is the only data point that's worth looking at. School discipline data, principals' anecdotal observations. I think we need to triangulate these. So go ahead and look at juvenile justice data or school reports of disciplinary action or confiscated drug materials on campus; sure and those are all valid data points and they speak to different things because I think that indicates use on school property which is different than youth use overall because our survey doesn't ask about where they use. So the fact that they're bringing more things to school or using more openly might be a different issue perhaps than frequency of use, which is what our survey looks at.
>
> There is very likely some underreporting. There is some evidence of some overreporting on some youth surveys. It depends on how much students feel that their responses are confidential and we do paper based and that's kind of mandated by the [Centres for Disease Control and Prevention] CDC and the idea is that youth can feel a high degree of confidence because they can cover their answers and

[3] A summary of this document is available in the Appendix of Subritzky (in preparation).

they protect it and as we move to maybe tablets you maybe have that privacy but with big computer screens they just don't, right?

However, Monitoring the Future and the [Youth Risk Behaviour Survey] YRBS both use school-based sampling. Very different efforts and they've both been going on for a long time and nationally and in these states we're seeing the exact same patterns. So, we're not an anomaly in Colorado. The national estimates of marijuana are flat. So the secular trends were consistent with that. So there is something larger than just our laws and our sample is just massive. I mean, 20,000 students. It's very robust. Then, national survey drug use and health which use very different sampling methods. They do in person interviews whereas we do paper based.

Our survey, we have 100 questions on there. **Ashley Brooks-Russell, PHD - Assistant Professor UC Denver. Project Director Healthy Kids Colorado Survey, Denver, May 2017**

The above-detailed outline of the HKC survey is persuasive and highlights how data collection is evolving generally with the advent of technology and also in regard to cannabis data collection specifically - most notably with the addition of new questions. Despite the critique of self-report data, there is no evidence in the case of the HKC survey at least that reported rates of consumption should be called into question, particularly as they mirror trends identified in other state and national surveys.

Despite these data indicating 'positive trends', there was near consensus in related interviews that it was too early make definitive judgments on policy outcomes. The impact data presented above can be considered initial indications that will likely evolve over decades. The following example is representative:

I think it's too early to know … we caveat it by saying in the first three years we haven't seen an increase in youth use. **Larry Wolk, MD - Executive Director CDPHE, May 2017, Denver.**

The above extract emphasizes how it will likely take years of accruing a variety of data points to formulate an accurate picture of consumption patterns in what is an ever-evolving landscape both in terms of policy and consumption patterns. Nonetheless, the above perspectives are among the first to document the first years of experience in a 'real-world' legal commercial cannabis market and provide a starting point around which further evidence can accrue.

The evolving message in prevention education: what are facts and how should they be framed in legalized contexts?

Notwithstanding that the appropriation of funds from CRCM revenue for youth prevention education programs was delayed as noted above, from the interviews it was apparent there were varying perspectives associated with how prevention education should be approached in a jurisdiction where a formerly illegal substance became legal. Interview participants differed in their perceptions of what 'public health messages' should be promoted, with options ranging from any consumption under the age of 25 having potentially catastrophic outcomes through to arguments that adolescents don't respond to brain damage messaging and thus the focus should be on engagement. An example of this challenge was described in an interview:

So that was an initial struggle I think for us as a local public health entity trying to be able to describe here's what the health impacts are … among youth that are going to be using marijuana before they reach the age of 25. So that was maybe the first piece - just trying to have a conversation and talking about some of the benefits while also talking about some of the downsides or some of the risks associated with it. **Heath Harmon, Director of Health Division for Boulder County Public Health, August 2017, Skype.**

An advocate for very strong messaging explained her perspective:

I met … an adolescent psychiatrist at Columbia, [he told me] that adolescents who started smoking pot at 13, when they walk in at 18, he has found that there's been permanent brain damage for the most part where their motivation has been lowered and their I.Q.

I live in a state that legalized marijuana and I would like to think that they're responsible enough to educate young people to stay away from this and not try it until they're much older if they want to try it, like 25 when your brain is fully developed. **Lexie Potamkin, Founder Principals for Principles, May 2017, Aspen**

As noted above, 13 years of age is considered a high-risk demographic for the initiation of a cannabis consumer career. While the argument has already been presented that early onset of cannabis consumption increases risks associated with cannabis (such as cannabis use disorder), the recommended age of a minimum of 25 in this extract is at the most cautious end of the spectrum (in line with NIDA guidelines previously described).

In Colorado where legal ages of consumption are set at 18 and 21 for medical and recreational respectively, preventing consumption until 25 may not be a realistic goal for public health officials or regulators. The demographic of 18–20-year-olds who may consume cannabis legally if they have obtained a medical card further complicates matters. Questions can be raised about the difficulties of enforcing this recreational age limit at places such as universities where thousands of accounts of cannabis consumption have been documented in the grey literature (e.g. Perry, 2005), and it would seem reasonably self-evident that university students may be exposed to cannabis in a legal environment, and are a likely target for diversion.

How cannabis prevention messages should be framed, particularly for those under 18, is an important consideration. While the above extract emphasizes brain damage to those under 25 as central to the potential message, alternative views on prevention education were also presented in the interviews. For example, Dr Wolk, Executive Director of the CDPHE claimed that his department had learned lessons around that style of messaging and moved away from emphasizing brain damage as central to education campaigns. The extract below highlights contrasting approaches to messaging.

I think we learned a lesson because we adopted a program shortly after I got here from the Governor's office which took this biased approach [Don't be a lab rat]. You know, [the campaign had] life-sized cages and of course the advocates became unglued, [they] were trying to set up images of jails and criminalization and of course people would go into these cages and take selfies of getting high.

And public health means you have to engage the people who are most likely to use … So, we have to engage and educate … we completely changed the tone of the campaign. So, now it's lighter. It's got more of an engagement strategy.

The other thing that we really learned as it related to kids is they don't want to hear about how it's bad for their developing brain or causing brain damage.

They were more likely to be impacted by messages around how marijuana could get in the way of what's next, so we targeted towards you might not be able to graduate. You might not be able to drive a car. You might not be able to get a job. You know all of these things are affected by using marijuana when you're still in your youth.

…

[One] component is the trusted adult campaign, which as our research and our survey data shows, that if kids have a trusted adult, they're less likely to engage in all kinds of behaviours; marijuana use, other drug use, alcohol, sex, whatever it is. Those who are teachers, doctors, coaches.

> *You know aunts, uncles, whoever, to say you're the key to what's going to keep kids from using marijuana, not the public health department or doctors even.* **Larry Wolk, MD - Executive Director CDPHE, May 2017, Denver**

The above text provides an example of prevention messages in legalized contexts reportedly evolving after originally taking a more penal focused approach, with an emphasis on engagement. There are challenges to finding the right balance between scaremongering, which could potentially lack authenticity and isolate adolescents, or playing down potential harms associated with early initiation of cannabis use. A second point relates not to the message itself, but who is presenting it. The contention that youth pay more attention to trusted adults than public health officials is important with the apparent implication that education campaigns also need to provide parents with factual information.

An additional point is that this prevention education campaign strategy appears to focus solely on the harms associated with the enforcement of prohibition for those underage as opposed to any harms resulting from consumption of the drug *per se*. It is unclear whether this was a deliberate strategy as this was not addressed in interviews. Finally, the controversial nature of this engagement strategy was highlighted by a senior regulator in an interview:

> *I think other people argue, "No that's a place where you're letting the industry soften your message". But hard messages haven't worked and so we try to stick with messaging that we know that works.* **Andrew Freedman, Director Office of Marijuana Coordination (Governor's Office), November 2016, Denver.**

Discussion

Comparing the data sets

Analysis of data set 1 (government documents) established that youth protection was stipulated as a priority objective by regulators, with the main focus being on advertising restrictions and the importance of education programs to reduce risks. In data set 2 (key stakeholder interviews), identified issues included the delayed appropriation of related funding, challenges relating to impact assessment, and evolving messages in prevention campaigns. Thus, in comparing the two data sets, tentative associations can be proposed between stated policy objectives and outcomes.

Despite real-world challenges and limitations to public health best practice that were identified (e.g., delays to initial funding for related youth prevention campaigns and challenges to data collection for impact assessment purposes), multiple interviewees commented on data reporting no statistically significant increase in observed youth consumption patterns in the initial years of the CRCM implementation. These comments can be linked to the latest consumption data from 2019 noted in the Introduction that indicate a continuation of that trend.

The evolution of prevention messaging campaigns to more of an engagement strategy by the CDPHE was established according to an account by the executive director of the CDPHE. Beyond indicating 'encouraging trends', the relationship between prevention education strategies and youth consumption rates is still emerging and more research is needed to further examine the effectiveness of prevention campaigns. However, the current study makes a novel contribution to the cannabis policy literature by highlighting these initial associations.

Lessons and recommendations

Numerous lessons can be learned from the Coloradan experience of implementing a legal commercial cannabis market, thereby potentially informing recommendations for other jurisdictions. First, developing education material and programs is a multi-department effort that draws on public health, education, human services, and public safety departments, among others. Leveraging the resources of these departments should be a goal of legalization regulators.

Second, in Colorado it is apparent that public health initiatives including youth prevention education programs were to be funded in the second round of appropriations, that is, in the second-year post-implementation. While it is understandable in the context of implementing the world's first adult-use cannabis market that regulators did not want the implementation of the new industry to be seen as a burden on taxpayers, from a public health perspective and with the benefit of hindsight, prefunding prevention education programs would seem to warrant consideration.

Third, in line with previous observations from cannabis scholars (e.g. Caulkins et al., 2015), the ballot-led initiative in Colorado appears to have hindered public health best practice as demonstrated by the example of basing advertising restrictions on the existing alcohol rule of 30% likelihood of being seen minors. A complete ban on cannabis advertising remains the recommended public health position. This implies that legislative change to cannabis prohibition may better align with public health objectives than ballot measures.

Fourth, prevention messaging campaigns may need to evolve from abstinence-only towards harm reduction because from the examples presented above, public health officials have concluded that abstinence-only approaches have not been effective. When considered in the political context, this shift may seem to be 'softening the message' and will require further consideration among a range of stakeholders, including those in human services and public health, to frame messages in a fashion that does not downplay risks associated with cannabis consumption. On the other hand, based on the Coloradan experience, it seems apparent that an engagement strategy with youth that focuses more on the immediate punishments facing youth than the potential harms associated with consumption *per se* may be more effective than highlighting risks associated with the developing brain.

Fifth, parents and trusted adults play an important role in informing, educating, and ultimately preventing youth consumption. As such, resources need to be allocated to educating this group. These might include specific funds for campaigns that target parents and carers. It seems apparent that messaging may be less effective if perceived as moral lecturing, so offering caregivers training on how best to engage youth should be prioritized.

Sixth, data collection needs to begin in advance of any roll out of legal markets to establish baseline consumption rates and the issue of how school discipline data are recorded. This includes understanding what data are being collected before the market is implemented and making decisions around whether these data will be appropriate to adequately assess the impacts on youth post-implementation. If not, changes will need to be made to ensure that data collected pre and post-implementation are like-for-like comparisons.

Seventh, despite the Mayor of Denver declaring the prevention messaging campaigns "a success", from the perspectives presented in this paper it is still too early to judge youth consumption outcomes. In this sense, regulators in other jurisdictions should be cautious regarding youth consumption patterns. Supporting this cautious approach, a recent systematic review has suggested legalization of cannabis for recreational purposes may be associated with a small increase in levels of use among youth that warrants further monitoring (Melchior et al., 2019).

Study limitations

The present study has a number of limitations including that it is specific to circumstances in Colorado and as such has limited generalizability, however it does start to build an evidence base of strategy and outcomes. Furthermore, the sample size of interview participants was relatively small, although this is balanced somewhat by the rich

experience and seniority of interviewees in the regulatory process. In addition, the study did not analyses education campaigns in local jurisdictions. Finally, the commercialization of medical cannabis in Colorado makes it difficult to draw inferences specific to the recreational market.

Declaration of competing interest

None

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Declaration

First author runs website www.marijuanasurveys.org and has researched the efficacy of cannabidiol (CBD) for a US pharmacy.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.drugpo.2019.09.007.

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