

Awareness, Perception of Risk and Behaviors Related to Retail Marijuana Among a Sample of Colorado Youth

Sheana S. Bull¹  · Ashley Brooks-Russell¹ · Jonathan M. Davis² · Rebecca Roppolo³ · Karen Corsi^{1,2}

Published online: 17 September 2016
© Springer Science+Business Media New York 2016

Abstract Youth marijuana use is a growing concern with increasingly permissive views towards marijuana use. Little is known about attitudes and beliefs toward marijuana use among youth in the context of legalization. This study describes youth attitudes and beliefs about health risks associated with marijuana use, social norms of peer use, conversations with parents about marijuana use, and knowledge of recreational marijuana laws, using a venue-day-time sampling approach with diverse Colorado youth ($n=241$) post-legalization. We considered demographic (gender, racial/ethnic and geographic) differences in knowledge of laws and perceptions of risk using bivariate and multivariate analyses. While many youth are knowledgeable about retail marijuana laws in Colorado, males were 2.12 times more likely to be familiar with laws compared to females. While 40% of the sample perceived a moderate to high risk from weekly marijuana consumption and 57% from daily consumption, fewer males perceived these risks. Over $\frac{3}{4}$ of the sample indicate they discuss marijuana with parents, but many fewer indicate discussing consequences and health effects of use with parents. Results suggest opportunities for parents and clinicians to influence youth attitudes and behaviors towards marijuana

use. It may be worthwhile to target educational campaigns to different demographic groups, and to offer training and capacity building for parents to discuss marijuana with their teenaged children.

Keywords Marijuana behaviors · Adolescents · Recreational marijuana use

Background

Nearly one quarter of U.S. youth aged 13–18 (23%) (hereafter called youth) report marijuana use in the past 30 days [1]. The prevalence of having ever used marijuana among U.S. youth (40.7%) is nearly the same as for cigarette smoking (41.1%) [1] and nationally, daily use of marijuana is more common than daily cigarette smoking [2]. This relatively high prevalence of use is concerning considering that youth marijuana use is not without risks. Youth marijuana use, particularly frequent use and use starting at a younger age, is associated with an increased risk for cannabis use disorder [3, 4], impaired cognitive abilities [5–7] and decreased educational achievement [8–11].

Monitoring the Future, an ongoing survey of 50,000 8–12th graders that has been ongoing since 1975 documents that youth attitudes towards marijuana use have been trending toward greater acceptance of use; there was a significant decline from 2014 to 2015 in perceived risk of regularly smoking marijuana, and disapproval of those who smoke regularly edged slightly downward [2]. Recent research indicates youth have increasingly permissive views on use [12]. This reflects the same secular trend seen in adults, where now a majority of adults in the U.S. favor legalization of marijuana [13]. However little is known about youth

✉ Sheana S. Bull
sheana.bull@ucdenver.edu

¹ Department of Community and Behavioral Health, Colorado School of Public Health, University of Colorado, 13001 E. 17th Place B119, Aurora, CO 80045, USA

² Department of Psychiatry, School of Medicine, University of Colorado, Aurora, CO, USA

³ Colorado Department of Public Health and Environment, Denver, CO, USA

attitudes and beliefs toward marijuana use beyond an overall perception of risk or disapproval.

Colorado is among the first states to pass a law permitting the legal sale of recreational (non-medical) marijuana for adults ages 21 and older. Currently, three additional states and D.C. have decriminalized or allow legal recreational marijuana use [14]. Retail sales began in Colorado on January 1, 2014, and sales topped \$990 million in 2015 [15]. Colorado provides a relatively unique environment for studying youth marijuana use, attitudes, and beliefs. In states like Colorado, parents face a difficult challenge communicating risks associated with marijuana use to their children in the presence of conflicting messages about the medicinal benefits of marijuana use [16]. Given that parents frequently underestimate the amount of their youth's substance use and that parent-child communication is inconsistent regarding substance use more generally [17], it is possible that parents are not having conversations with their youth about marijuana use.

The Current Study

After passage of the Amendment 64 ballot measure to legalize marijuana, Colorado legislators charged the Colorado Department of Public Health and Environment (CDPHE) to create statewide informational campaigns to educate Colorado residents and visitors on the parameters of safe, legal and responsible use of recreational marijuana through prevention and public awareness activities (Colorado Revised Statute, 2014). Funding for these activities was set aside from the tax revenue from the sale of recreational marijuana. The purpose of this paper is to offer data to inform state funding for youth prevention strategies to increase perceptions of risk about recreational marijuana health effects, increase accurate knowledge of the marijuana laws, and influence parent conversations with adolescents about marijuana.

Methods

Sample Design

We used a venue-day-time (VDT) sampling methodology to identify and recruit 241 youth (13–18 years old) statewide for the survey. This approach offers rigor superior to a convenience sample, while allowing for potentially greater access to groups when a topic is stigmatized or touches on illegal activity [18]. Counties for the survey were stratified based on their overall population, including counties with the highest and lowest numbers of residents; counties with the highest numbers of Hispanic and African-American residents; counties with high numbers of youth under age 21;

and counties representing urban and rural populations; we selected counties at random from within each of these strata. Shown in Fig. 1 are all the counties (marked with a star) entered into the sampling frame. Those selected at random from among those in the sampling frame included urban counties (Denver, Adams, and El Paso) as well as rural and semi rural counties (Weld, Mesa, Eagle, Rio Grande and Alamosa).

Once counties were selected, staff identified community organizations, public settings and businesses where we would be likely to encounter youth targeted for the survey. Staff contacted representatives from these organizations, settings and businesses to explain the purpose of the venue-day-time survey and obtain permission for recruiting survey participants in these settings. When a location identified was a public setting, we did not obtain permission (e.g. a city park or street corner).

Once we identified locations to recruit participants in each county, we went to these locations and generated estimates of how many people we could survey from our target audience in a 2.5-hour period. Staff went to the venue on days of the week and times of the day when there was an anticipated high volume of participants and counted the potential participants they observed entering the venue. If we estimated a yield of at least six completed surveys in a given venue on a specific day and time, it was included in the final sampling frame. These venue-day-times (VDTs) comprised the final sampling frame.

We chose VDTs at random from within this sampling frame for each sampled county and sent staff on the selected days and times to approach potential survey participants and invite them to complete a survey. Data collection began November 30, 2014 and continued through January 4th, 2015. We approached 394 youth in study venues; of these, 294 or 75% were eligible for participation. Of these, 241 or 82% agreed to participate.

Data collection staff included at least two people per VDT. Surveys were self-administered by participants on tablets into the Research Electronic Data Capture (REDCap) system, an online survey tool that stores data behind firewalls at the University of Colorado. All surveys were anonymous and collected no identifiers beyond age, gender, race/ethnicity and zip code.

Measures

Participants were asked about multiple elements of recreational marijuana laws including (a) legal age of recreational marijuana use (open-ended response), (b) legal locations for marijuana use (in a home, in a business, in an outdoor public place, don't know/not sure, don't want to answer), (c) if an individual who is driving after using marijuana could be ticketed for driving under the influence

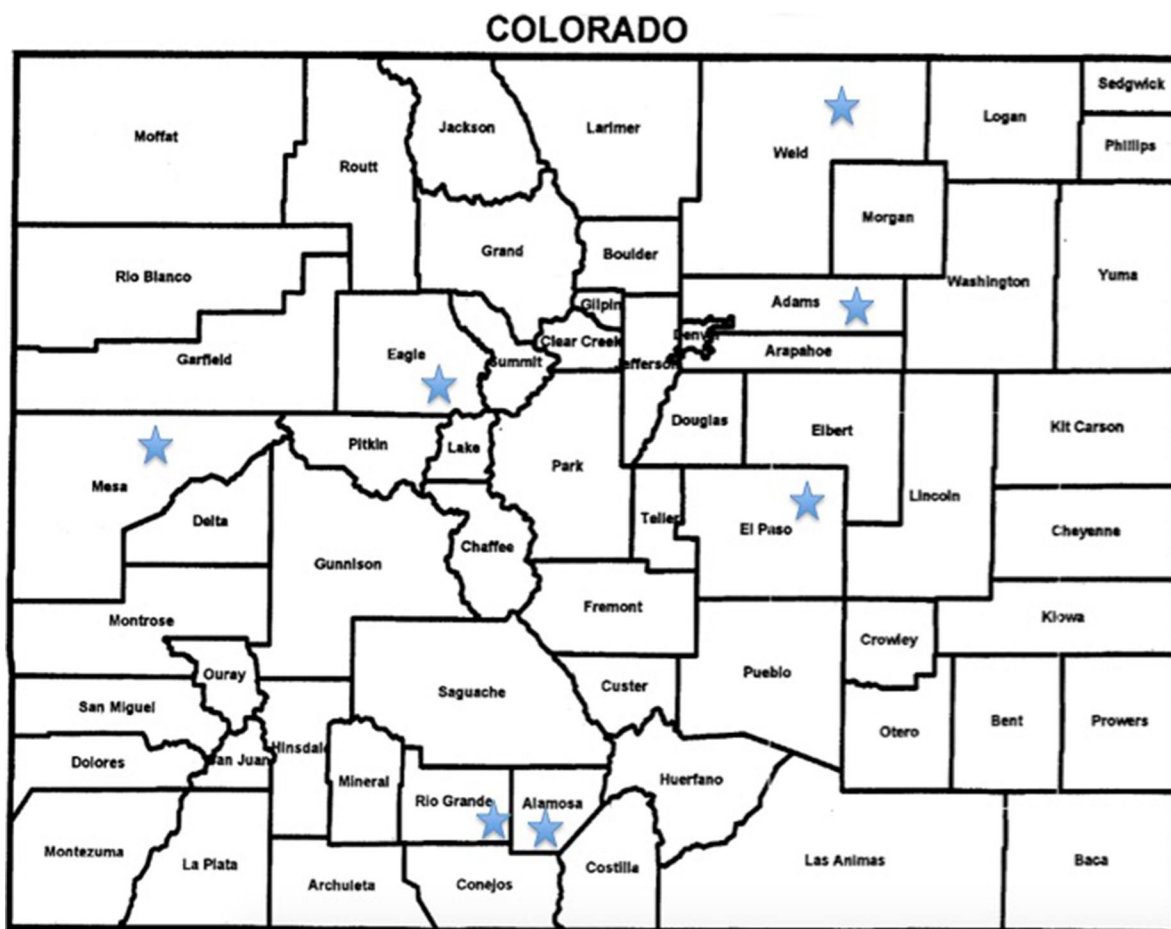


Fig. 1 Counties where data were collected selected at random are marked with a *star*

(yes, no, don't know/not sure, don't want to answer). For analysis, each response was collapsed into a binary response (1 = correct knowledge of the law and 0 = incorrect or lack of knowledge of the law). Correct knowledge was defined as reporting age 21 to buy, marijuana can be used in a home but not in a business or outdoor public place, and an individual using marijuana can be ticketed for driving under the influence.

We asked youth to share their perceptions of risk associated with daily and weekly marijuana use for adults and youth, use while pregnant and breastfeeding, and perceptions of risk in extracting hash oil, in exposure via second hand smoke and through consumption of edibles.

We asked youth about their own use and perceived use among friends. Participants rated perceptions of risk along a Likert scale from "No risk", "little risk" to "moderate risk" and "high risk". Moderate and high risk were collapsed into a single item representing perceived risk associated with marijuana use. We asked youth to indicate by responding yes or not to queries about whether their parents and care providers discussed various aspects of marijuana use with them.

We created two composite score variables similar to previous work [19, 20] designed to capture a broad level of knowledge and perception of risk. These were utilized as outcome variables in multivariate regression analyses. The "knowledge of laws" composite score utilized the three items that were most central to the campaign's messaging by creating a variable that captured whether participants answered all of the marijuana laws correctly: (a) legal age of recreational marijuana use, (b) if it is legal to use marijuana use in an outdoor public place, and (c) if an individual who is driving after using marijuana will be ticketed for driving under the influence. Those who answered all three items correctly were given a score of 1 and all others were given a score of 0. We created a composite perception of risk score in a similar manner. This score ranged from 0 to 10 where 10 would represent a moderate or high-risk perception on all 10 aforementioned Likert scale risk perception questions. Table 3 presents items assessing perception of risk.

Demographic variables included gender (male, female) and race/ethnicity (African American, Hispanic, White, and Other race/ethnicity). Due to the high degree of missingness on the question about the use of marijuana in the past

30 days (105 of 241; 44% missing), presumably due to the illegality of underage use, we categorized respondents as current users, current non-users, and non-responders.

Analysis Plan

We conducted descriptive statistics with frequencies for all the survey measures for the sample with follow up multivariate regression on composite score variables. We compared knowledge of laws and risk attitudes in youth towards use between males and females, among diverse race/ethnicity and among geographic regions using χ^2 and Fisher’s exact test as appropriate.

We followed descriptive comparisons with multivariate logistic regression of the mentioned predictors (user group, gender, county and race/ethnicity) on the combined knowledge score variable. We also conducted multivariate linear regression analyses on the perceptions of risk variable. In all models we examined the following covariates: user group, gender, county of residence and race/ethnicity. Residual diagnostics did not suggest violations of linear assumptions in the case on the linear regression. Parsimonious models were selected through a backwards selection process that removed variables with p-values greater than or equal to 0.05. Analyses were conducted in R [21].

Results

Sample Characteristics

The sample is majority male (64%), and ethnically diverse with the majority of respondents being classified multi-racial Hispanic (43%; Table 1). The sample also included non-Hispanic African American (18%), non-Hispanic White (26%) and other (13%) (Table 1). Almost three quarters (73%) were from urban counties and the remainder rural or semi rural.

Knowledge of Retail Marijuana Laws

Table 2 shows data on knowledge of marijuana laws overall and stratified by gender and race/ethnicity. Youth were generally successful identifying specific laws; 68% could correctly identify the laws regulations related to legal age to purchase, 70% knew outdoor consumption is not permitted and 74% were aware one can get a DUI. However, only 45% of youth could correctly identify all three of these laws.

When exploring whether awareness of laws differed across geographic regions in this sample, we observed that 60% of front range youth are aware there are penalties for driving while high compared to 16% of all other youth (data not shown).

Table 1 Sample demographics (N=241)

Characteristic	n (%)
Geographic location	
Urban counties	
Denver/Adams County	128 (53)
El Paso	48 (20)
Rural/semi-rural counties	
Weld	12 (5)
Mesa	22 (9)
Eagle	12 (5)
Rio Grande and Alamosa	19 (8)
Language	
Primarily Spanish	28 (12)
English	201 (83)
Race/ethnicity	
White	64 (27)
African American	49 (20)
Multi-racial Hispanic	103 (43)
Other	25 (10)
Gender ^a	
Female	84 (36)
Male	152 (64)

^aTwo ‘non-response’ and three transgender individuals were not included in the analysis

Perception of Risk and Health Effects

As presented in Table 2 only 40% of youth perceived a moderate or high level of risk to teens from weekly use of marijuana and just over half (57%) perceived moderate or high risk to teens from daily use. Similarly just over half (55%) perceived a moderate or high risk to children from second hand smoke exposure.

When considering unadjusted differences among respondents, males were more aware of the legality of use outdoors in a public space, but less frequently perceived high to moderate risk associated with daily use among adults. Females more often perceived childhood exposure to second hand smoke, consumption of more than one serving of edibles, use while pregnant, and extracting hash oil at home, as having high to moderate risk compared to males.

We did not document unadjusted differences in the knowledge of laws across diverse racial/ethnic groups. However perceptions of risk were generally different by race/ethnicity, perhaps most notably those self-identifying as “other” did not perceive as great a risk of adult daily use compared to their peers.

Also shown in Table 2 are data on perceptions of peer use as well as personal experience and parental communication. Many teens surveyed indicate that most or all of their friends use marijuana (40%), and over half consider that

Table 2 Knowledge of the Colorado retail marijuana laws and perceptions of risk associated with marijuana use by gender, race/ethnicity

Question	Gender		Race/ethnicity				Total ^a (n = 241) N (%)
	Male (n = 152) N (%)	Female (n = 84) N (%)	African American (n = 44) N (%)	Hispanic (n = 103) N (%)	White (n = 62) N (%)	Other (n = 32) N (%)	
Knowledge of laws							
Has awareness of key laws: legal age, outdoor consumption, and DUI	76 (53)*	28 (34)*	13 (31)	51 (52)	31 (51)	12 (40)	109 (45)
Legal age to purchase marijuana is 21	104 (75)	56 (68)	27 (66)	79 (80)	39 (66)	19 (73)	165 (68)
Cannot consume marijuana in an outdoor public space	115 (79)*	49 (60)*	31 (70)	72 (74)	46 (75)	19 (66)	169 (70)
Can be ticketed for using and driving	118 (80)	62 (75)	31 (74)	80 (78)	50 (83)	23 (74)	183 (74)
Can consume marijuana in a private home	114 (79)	57 (70)	33 (75)	75 (77)	49 (80)	17 (59)	171 (71)
Cannot consume marijuana in a business open to public	105 (72)	58 (72)	34 (77)	72 (74)	40 (66)	19 (66)	183 (76)
Perceptions of health effects							
Marijuana can cause depression or anxiety	59 (43)	39 (53)	16 (41)	46 (51)	29 (50)	8 (30)	99 (41)
Wait 6 h after using to drive	82 (56)	51 (66)	20 (48)+	71 (72)+	26 (45)+	17 (57)+	134 (55)
Daily use leads to addiction	71 (48)	45 (60)	25 (60)+	58 (61)+	26 (44)+	10 (33)+	119 (49)
Marijuana use during pregnancy leads to attention problems and lower IQ	90 (73)	56 (78)	26 (68)	70 (84)	33 (66)	20 (69)	149 (62)
Daily use marijuana leads to impaired memory	88 (64)	57 (76)	22 (56)+	75 (81)+	38 (70)+	15 (48)+	150 (62)
Perceptions of risks							
High to moderate risk in adult daily use	54 (36)*	47 (59)*	23 (55)+	51 (50)+	20 (33)+	9 (29)+	101 (42)
High to moderate risk in teenager using once a week	58 (39)	39 (48)	19 (44)+	51 (50)+	16 (27)+	13 (42)+	97 (40)
High to moderate risk in teenager using daily	88 (59)	50 (63)	28 (68)	64 (64)	33 (56)	16 (50)	138 (57)
High to moderate risk in women using often while pregnant	99 (70)*	66 (87)*	34 (76)	69 (73)	49 (82)	17 (74)	165 (68)
High to moderate risk in mother using while breastfeeding	108 (74)	63 (83)	39 (91)	74 (77)	40 (70)	22 (73)	171 (71)
High to moderate risk in extracting hash oil at home	79 (57)*	49 (73)*	27 (68)	52 (60)	35 (65)	18 (60)	128 (53)
High to moderate risk children being exposed 2nd hand marijuana smoke	79 (54)*	54 (70)*	26 (63)	65 (68)	29 (49)	17 (53)	133 (55)
High to moderate risk of consuming more than one portion of edibles	65(44)*	45 (62)*	24 (62)	51 (53)	23 (38)	15 (47)	110 (46)
High to moderate risk in storing marijuana in open containers in a home with children	85 (58)	54 (68)	33 (75)+	64 (67)+	29 (49)+	17 (55)+	139 (58)
Perceptions of peer use							
How many of your friends do you think use marijuana: Most-All	65 (44)	34 (40)	22 (50)++	31 (31)++	33 (53)++	16 (53)++	102 (41)
How many of peers your same age do you think use marijuana: Most-All	80 (54)	47 (56)	30 (68)++	44 (44)++	42 (68)++	13 (43)++	129 (54)
Parental communication							
How likely is it that any of the people who live with you use marijuana: Likely	67 (50)	30 (40)	21 (49)	37 (41)	31 (60)	11 (39)	100 (41)
Parents/guardians have talked with you about marijuana use	122 (82)	59 (72)	30 (68)+	80 (80)+	56 (90)+	19 (66)+	185 (77)
Parents/guardians have discussed if you use to be careful	59 (39)	25 (30)	15 (34)	34 (33)	28 (45)	9 (28)	85 (35)
Parents/guardians have discussed the health effects of marijuana with you	45 (30)	26 (31)	9 (20)	36 (35)	17 (27)	10 (31)	72 (30)

Table 2 (continued)

Question	Gender		Race/ethnicity				Total ^a (n = 241) N (%)
	Male (n = 152) N (%)	Female (n = 84) N (%)	African American (n = 44) N (%)	Hispanic (n = 103) N (%)	White (n = 62) N (%)	Other (n = 32) N (%)	
Parents/guardians have discussed the consequences of using marijuana with you	52 (34)	32 (38)	13 (30)	38 (37)	26 (42)	8 (25)	85 (35)
Parents/guardians have told you not to eat marijuana edibles	17 (11)	15 (18)	3 (7)	19 (18)	6 (10)	4 (13)	32 (13)
Parents/guardians have told you not to drive after using marijuana	43 (28)	18 (21)	6 (14)	33 (32)	15 (24)	8 (25)	62 (26)
Parents/guardians have discussed news reports concerning marijuana with you	10 (7)	12 (14)	2 (5)	9 (9)	8 (13)	4 (13)	23 (10)
Parents/guardians have discussed their personal experience with marijuana with you	29 (19)	18 (21)	4 (9)++	17 (17)++	21 (34)++	6 (19)++	48 (20)
Spoke with a care provider in the past 12 months about marijuana use	45 (33)	28 (37)	15 (39)	31 (33)	24 (40)	7 (28)	73 (30)
Easy to get marijuana if you wanted it	110 (76)	54 (67)	25 (57)++	71 (72)++	49 (84)++	24 (83)++	169 (70)
Definitely or probably will be using marijuana in 5 years	81 (58)	23 (29)*	22 (52)	38 (40)	35 (60)	12 (43)	104 (43)

Bold values indicate significance; * $(\chi^2, d.f. = 1, p\text{-value} < 0.05)$, + significant $(\chi^2, d.f. = 3, p\text{-value} < 0.05)$, ++ significant (Fisher's Exact, $p\text{-value} < 0.05$)

^aThe columns include sample sizes that add up to more than 241; this is because people can select multiple racial categories, and can also identify as Hispanic in addition to a single or multiple racial categories. Additionally, the proportions and N shown in the total column include the entire sample, whereas those shown for male and female include only 236 participants who identified as male or female (see notation on Table 1)

most or all of their peers use marijuana (54%); significantly higher proportions of African American and white youth indicate friend and peer use than Hispanic and “other” teens. Many teens perceive that people they live with consume marijuana (41%) and, while youth overall indicate their parents have discussed marijuana use with them generally (77%), significantly greater numbers of Hispanic youth and white youth acknowledge this compared to African American and “other” youth. Fewer indicate that their parents specifically discussed consequences of marijuana use (35%), health effects (30%), or directly admonished youth to avoid edibles (13%) and to avoid driving while high (26%). Just under one-third (30%) indicated that a medical provider has discussed marijuana use with them. Over two-thirds (70%) indicate marijuana is easy to get if they wanted it. Of note a higher proportion of non-Hispanic, white individuals had discussions with their parents in which their parents shared personal marijuana experiences. While 43% overall indicate they will likely be using marijuana in 5 years, significantly more males than females indicated this.

There were 84 of the 241 youth participating who indicated they had used marijuana in the past 30 days (35%). Fifty-three (22%) indicated they did not use marijuana in the past 30 days and 104 (43%) youth refused to answer the question. Univariate analyses suggested a lower perception of risk in those who identified as users regarding scenarios of frequency of use including; adult use once per week, adult daily use, and teenager daily use (Table 3).

Multivariate analyses of “knowledge of laws” (Table 4) identified males with increased odds of knowledge over females (OR = 2.12, $p = 0.013$), non-responders with reduced odds (OR = 0.43, $p = 0.012$) versus users, and non-Hispanic African Americans with reduced odds (OR = 0.37, $p = 0.016$) versus multiracial Hispanics. County was not a significant predictor of the knowledge score variable. Linear multivariate analyses identified significant predictors of perceptions of risk including males with reduced risk perceptions versus females ($b = -1.37, p = 0.004$), and geographic differences in risk perception, where Mesa, Alamosa and Weld all had greater perception of risk than individuals in Denver County ($b_{\text{Mesa}} = 1.84, p = 0.023, b_{\text{Alamosa}} = 2.46, p = 0.004, b_{\text{Weld}} = 2.97, p = 0.002$). Conversely user group and race/ethnicity were not significant predictors of higher perceptions of risk (data not shown).

Discussion

We present data from a community survey using a probability VDT sample of youth systematically selected for participation to document knowledge of Colorado recreational marijuana laws, attitudes towards and perceptions of risk from use.

Table 3 Knowledge of marijuana laws and perceptions of risk among youth by those who indicate using marijuana compared to those not indicating use or not responding to question on use

Question	Non response (n = 104) (%)	Non user (n = 53) (%)	User (n = 84) (%)	p-value
Can be ticketed for using and driving	75 (74.3)	46 (90.2)	63 (75.9)	0.05^a
Can consume marijuana in a private home	64 (65.3)	39 (78.0)	71 (85.5)	0.01
Marijuana can cause depression or anxiety: agree	49 (58.3)	23 (45.1)	27 (33.8)	0.01
Wait 6 h after using to drive: agree	69 (74.2)	34 (66.7)	31 (36.9)	< 0.00
Daily use leads to addiction: agree	61 (65.6)	23 (45.1)	35 (42.7)	0.00
Marijuana use during pregnancy leads to attention problems and lower IQ: agree	74 (86.0)	32 (72.7)	43 (61.4)	0.00
Daily use marijuana leads to impaired memory: agree	71 (79.8)	32 (64.0)	47 (60.3)	0.02
Risk in adult using once per week	24 (23.8)	13 (25.5)	8 (9.6.8)	0.02
Risk in adult daily use	56 (56.6)	22 (43.1)	25 (29.8)	0.00
Risk in teenager using once a week	50 (49.5)	21 (41.2)	28 (33.7)	0.10
Risk in teenager using daily	69 (71.1)	26 (51.0)	46 (54.8)	0.02
Risk in women using often while pregnant	70 (76.1)	44 (84.6)	55 (69.6)	0.14
Risk in mother using while breastfeeding	78 (81.3)	36 (73.5)	61 (75.3)	0.48
Risk in extracting hash oil at home	55 (66.3)	26 (54.2)	51 (63.8)	0.37
Risk children being exposed second hand marijuana smoke	65 (69.1)	28 (56.0)	44 (52.4)	0.06
Risk in consuming more than one serving of edibles	84 (80.8)	48 (90.6)	77 (91.7)	0.06
Risk in storing marijuana in open containers in a home with children	67 (69.8)	30 (58.8)	46 (55.4)	0.12

Bold values indicate significant differences between groups

^aFisher's exact test employed. All other p values based on χ^2 estimates

We know of no other work that has presented current knowledge of laws and attitudes towards use and perceptions of risk among youth in locations where recreational use as well as medical marijuana is legal for adults (in Colorado, recreational marijuana is legal for those aged 21 and older, while medical marijuana is legal for those aged 18 and older, and for those under age 18 with parental permission and with a doctors recommendation). Knowledge of specific laws is important for youth, particularly for youth of color who have historically been notably and negatively impacted by the regulatory environment for controlled substances [22]. Documentation of youth attitudes towards use and perceptions of risk in an environment where marijuana is easy to obtain offers a better opportunity to document trends to later consider a relationship between more liberal attitudes towards use and increased risk.

Our data demonstrate that youth are generally quite knowledgeable about specific elements of the retail marijuana law in Colorado, although awareness of restrictions for use under the age of 21 may not translate into limited use, given that our sample felt that use is relatively common among peers and personal friends; certainly most of the

youth felt marijuana is easy to obtain. These data document higher perceived peer use than that of other sources—a representative sample from the Healthy Kids Colorado Survey indicates higher proportions of youth perceive regular use of marijuana as harmful compared to those in our sample [23]. It is not clear if this higher perception is due to the

Table 4 Multivariate logistic regression of knowledge of marijuana laws by individual characteristics

	OR	95 % CI	p-value
Non users ^a	0.95	0.45–1.97	0.89
Non response ^a	0.43	0.23–0.82	0.01
African American ^b	0.37	0.17–0.83	0.02
Non-Hispanic white ^b	0.88	0.44–1.73	0.715
Other ^b	0.51	0.28–1.23	0.13
Males ^c	2.12	1.17–3.82	0.01

Bold values indicate significance

^aReference is users

^bReference is Multiracial Hispanic

^cReference is females

difference in samples or to an increased perception of use since retail marijuana was legalized. We observed that significantly fewer youth who indicate use agree that marijuana use during pregnancy may be detrimental to child IQ or that daily use may contribute to impaired memory compared to those who indicate not using marijuana or who do not respond to a query on use. Young men from the sample as well as African American and Latino respondents were less often in agreement that daily use of marijuana among youth was risky compared to the whole sample, who more often consider daily use detrimental.

These findings suggest specific actionable areas for concern related to youth perceptions of marijuana risk and youth use of marijuana. While our data suggest that youth overall are well educated about marijuana laws and generally have some understanding of what the scientific evidence shows related to risks associated with use, we submit that increasing awareness of laws and perceptions of risk is a priority for public health in Colorado. These suggestions underscore the fact that retail marijuana use remains illegal for those under the age of 21, and that there is evidence that chronic use, use during adolescence and use while driving is harmful. Additionally, with evidence demonstrating that youth substance use behaviors decrease when they are made aware that such behaviors are not normative we can consider future campaigns that target misperceptions regarding generalized youth marijuana use.

While many youth indicate that their parents have spoken to them about marijuana, many fewer indicate that their parents have specifically discussed health effects of marijuana use or consequences of use, and few overall have admonished their teens to be careful about using, about edibles in particular, and driving while high. Additionally, few teens have spoken with a clinical provider about use. This suggests that helping parents and clinicians to build skills in communication with teens about marijuana use is warranted. Given that parents remain an important influence on youth risk behavior in the teen years, [24–26] working to develop parent skills in communication will likely be beneficial for youth. It also remains imperative for educators, clinicians and other personnel in contact with youth bring the conversation about risk and health effects into the mainstream for youth.

It is critical that we target educational efforts to reach youth in relation to marijuana laws and risk. Based on the data presented here, it would be useful to develop strategies to reach young women regarding retail marijuana laws in particular. Also, young White male youth could use more messaging around specific risk behaviors. We also found some racial differences in perceptions of friends' consumption of marijuana, which may call for developing culturally appropriate messaging for racial subgroups. Specifically, these messages would dissuade perceptions of norms that

marijuana use is common. It can also be worthwhile to target efforts in the urban communities in Colorado to raise perceptions of risk, given the generally higher perception of risk in rural communities found here.

Strengths and Limitations

The VDT sampling approach is one that is methodologically more rigorous than one employing a convenience sample. Biases associated with non-random selection of venues days and times for data collection include such things as collecting data where it is most convenient for the staff, or on days of the week or times of the day that are preferred, meaning that participants in a given venue may have a greater likelihood of being selected and included in the sample. This is a more rigorous approach than a convenience sample because participants have an equal probability of being included in the sample, but it does not completely remove bias, so results are not generalizable to 13–18 year olds in Colorado.

Conclusion

It is important to continue to track youth attitudes and beliefs about health risks associated with marijuana use and social norms of peer use in an evolving legal climate and changing social norms. Parents and other influential adults (e.g., teachers, clinicians) have an important role in communication with adolescents and the risks of marijuana use.

Building upon these findings and other research, CDPHE launched a youth prevention campaign, *What's Next*, in the summer of 2015 with the objective is create a culture of non-use by helping young people realize their immediate goals and dreams are easier to achieve without marijuana through social media, video, and mobile content, and a simultaneous campaign to support “askable” adults (parents, guardians, educators, coaches and other youth-serving professionals) to reinforce the important reasons youth should not use marijuana.

Acknowledgments This work was supported with a contract from the Colorado Department of Public Health and The Environment.

References

1. Kann, L., Kinchen, S., Shanklin, S., et al. (2014). Youth risk behavior surveillance—United States, 2013. *Morbidity and Mortality Weekly*, 63(SS04), 1–168.
2. Johnston, L. D., O'Malley, P., Miech, R., Bachman, J., & Schulenberg, J. (2016). *Monitoring the future national survey results on drug use, 1975–2015: Overview, key findings on adolescent drug use*. Ann Arbor: University of Michigan.
3. Schuermeyer, J., Salomonsen-Sautel, S., Price, R., et al. (2014). Temporal trends in marijuana attitudes, availability and use in

- Colorado compared to non-medical marijuana states. *Drug & Alcohol Dependence*, 140, 140–155.
4. Hasin, D., Saha, T., Kerridge, B., et al. (2015). Prevalence of marijuana use disorders in the United States between 2001–2002 and 2012–2013. *JAMA Psychiatry*, 72(12), 1235–1242.
 5. Pope, H., Gruber, A., Hudson, J., Cohane, G., Huestis, M., & Yurgelun-Todd, D. (2003). Early-onset cannabis use and cognitive deficits: what is the nature of the association? *Drug & Alcohol Dependence*, 69(3), 303–310.
 6. Bolla, K., Brown, K., Eldreth, D., Tate K., & Cadet, J. (2002). Dose-related neurocognitive effects of marijuana use. *Neurology*, 59(9), 1337–1343.
 7. Medina, K., Hanson, K., Schweinsburg, A., Cohen-Zion, M., & Tapert, S. (2007). Neuropsychological functioning in adolescent marijuana users: Subtle deficits detectable after a month of abstinence. *Journal of the International Neuropsychological Society*, 13(5), 807–820.
 8. Stiby, A., Hickman, M., Munafor, M., Heron, J., Yip, V., & Macleod, J. (2015). Adolescent cannabis and tobacco use and educational outcomes at age 16: Birth cohort study. *Addiction*, 110(4), 658–668.
 9. Horwood, L. J., Fergusson, D. M., Hayatbakhsh, M., et al. (2010). Cannabis use and educational achievement: findings from three Australasian cohort studies. *Drug & Alcohol Dependence*, 110(3), 247–253.
 10. Brook, J., Balka, E., & Whiteman, M. (1991). The risks for late adolescence of early adolescent marijuana use. *American Journal of Public Health*, 89(10), 1549–1554.
 11. Fergusson, D. M., Horwood, L. J., & Beautrais, A. (2003). Cannabis and educational achievement. *Addiction*, 98(12), 1681–1692.
 12. Schmidt, L., Jacobs, L., & Spetz, J. (2016). Young people's more permissive views about marijuana: Local impact of state laws or national trend? *American Journal of Public Health*, 19, e1–e6.
 13. Doherty C, Tyson A, Weisel R. In debate over legalizing marijuana, disagreement over drug's dangers. 2015; <http://www.people-press.org/files/2015/04/04-14-15-Marijuana-release.pdf>, 2016.
 14. National Conference on State Legislatures (2015). Marijuana Overview. <http://www.ncsl.org/re-search/civil-and-criminal/C2%AC-justice/marijuana-overview.aspx> Accessed 1 May 2016.
 15. Colorado Department of Revenue: Marijuana Tax Data. <https://www.colorado.gov/pacific/revenue/colorado-marijuana-tax-data> Accessed 1 May 2016.
 16. Hopfer, C. (2014). Implications of marijuana legalization for adolescent substance use. *Substance Abuse*, 35(4), 331–335.
 17. Fisher, S., Bucholz, K., Reich, W., et al. (2006). Teenagers are right—parents do not know much: an analysis of adolescent-parent agreement on reports of adolescent substance use, abuse, and dependence. *Alcoholism*, 30(10), 1699–1710.
 18. Muhib, F. B., Lin, L. S., Stueve, A., et al. (2001). A venue-based method for sampling hard-to-reach populations. *Public Health Reports*, 116(Suppl 1), 216–222.
 19. Booth, R., Davis, J., Brewster, J., Lisovska, O., & Dvoryak, S. (2016). Krokodile Injectors in Ukraine: Fueling the HIV Epidemic? *AIDS and behavior*, 20(2), 369–376.
 20. Corsi, K. F., Dvoryak, S., Garver-Appar, C., et al. (2014). Gender differences between predictors of HIV status among PWID in Ukraine. *Drug & Alcohol Dependence*, 138, 103–108.
 21. R Statistical software [computer program] (2016). Version 3.3: The R Foundation.
 22. Committee on Substance Abuse Committee on Adolescence. (2015). The impact of marijuana policies on youth: Clinical, research, and legal update. *Pediatrics*, 135(3), 584–587.
 23. Colorado Department of Public Health and Environment. (2015) Healthy Kids Colorado Survey. <https://www.colorado.gov/cdphe/hkcs>. Accessed 1 May 2016.
 24. Pingel, E. S., Bauermeister, J. A., Elkington, K. S., Fergus, S., Caldwell, C. H., & Zimmerman, M. A. (2012). Condom use trajectories in adolescence and the transition to adulthood: The role of mother and father support. *Journal of Research on Adolescence*, 22(2), 350–366.
 25. Skeer, M. R., Ballard E. L. (2013). Are family meals as good for youth as we think they are? A review of the literature on family meals as they pertain to adolescent risk prevention. *Youth Adolescence*, 42(7), 943–963.
 26. Brody, G. H., Murry, V. M., Gerrard, M., et al. (2004). The strong African American families program: Translating research into prevention programming. *Child development*, 75(3), 900–917.