Usual Modes of Marijuana Consumption Among High School Students in Colorado

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ABSTRACT. Objective: The purpose of this study was to assess the prevalence of modes of marijuana consumption among Colorado youth and explore variation by demographics, access, substance use, and risk perceptions. **Method:** Data are from a 2013 survey of Colorado high school students ($N = 25,197$; 50.5% female). The outcome variable was usual mode of marijuana consumption (i.e., smoking, vaporizing, ingesting edibles, or other) among those reporting past 30-day marijuana use. Classification variables included sex, grade level, race/ethnicity, sexual orientation, current alcohol and cigarette use, frequent marijuana use, early marijuana use (<13 years), perceived harmfulness, and perceived wrongfulness. We calculated prevalence estimates overall and by the variables listed above, and also conducted multinomial logistic regression models. **Results:** Findings indicate that 15% of Colorado high school students who use marijuana report that they usually use a mode of consumption other than smoking. Among students reporting past 30-day marijuana use, 85% said smoking was their usual mode of consumption. The remainder reported that their usual mode of consumption was vaporizing (6%), ingesting edibles (5%), or another method (4%). Boys, Whites, Asians, and 12th graders were the most likely to report vaporizing. High perceived harmfulness was associated with vaporizing or ingesting edibles. **Conclusions:** The majority of Colorado youth who use marijuana usually smoke it. Youth may be using vaporizers and ingesting edibles as a way to reduce the harm associated with inhaling combusted smoke. (*J. Stud. Alcohol Drugs, 77,* 580–588, 2016)

IN 2013, 23% OF U.S. HIGH SCHOOL STUDENTS reported past 30-day marijuana use, and the lifetime prevalence of use among this population (40.7%) was equivalent to the lifetime prevalence of cigarette smoking (41.1%) (Johnson et al., 2015; Kann et al., 2014). Rates of marijuana use are higher among older adolescents; data from the 2014 Monitoring the Future survey show that 44.4% of 12th graders report lifetime use (Johnston et al., 2015).

Adolescents may use marijuana for several reasons, including for pleasure, as an activity to do with friends, to cope, or even to emulate adults. Although most who experiment with marijuana will not experience significant negative outcomes, use comes with several potential harms.

Adolescent marijuana use is associated with an increased risk for cannabis use disorder as well as other problems, including motor vehicle crashes, cognitive impairment, poor school performance, lower levels of educational attainment, and health problems (Hall, 2006, 2015; Lynne-Landsman et al., 2010; Lynskey & Hall, 2000; Medina et al., 2007; Pope et al., 2003). The United States is experiencing significant social change regarding policy and social norms pertaining to marijuana (Pew, 2015), and adolescent marijuana use may increase as a result (Pacula, 2010).

Given the high prevalence of use among adolescents, potential adverse outcomes, and changing policy environment, it is important to monitor adolescent marijuana use at the population level. One way in which the nature of adolescent marijuana use may be changing relates to use of alternative modes for consuming marijuana. Specifically, the prevalence of consuming marijuana via vaporizers, edibles, and other modes may be increasing (Budney et al., 2015; Schauer et al., 2016).

Mode of marijuana consumption may have implications for initiation of use; repeated use and development of use disorders; and timing, length, and severity of intoxication. For example, vaporizing may be perceived as less harmful because smoke is not combusted and also may allow for more covert use given the reduction in odor. Because edibles have no odor, they are largely undetectable to parents. However, edibles may be harmful to new users because

of a limited ability to titrate exposure coupled with a longer duration of intoxication. Distinct modes of consumption may also have unique impacts on health and disease in the long term. The case of tobacco is instructive, because the risk for specific types of cancer varies by the form of tobacco used (e.g., snuff, chewing tobacco, and cigarettes present distinct risks for type of cancer) (Rodu & Cole, 2002; Rodu & Jansson, 2004). Therefore, understanding how frequently each mode of consumption is used will lay a foundation to link health outcomes to mode of marijuana consumption. In response to the need for epidemiologic data on this topic, we examine modes of marijuana use among Colorado high school students.

Marijuana policy landscape

California was the first state to pass a law removing criminal penalties for the use, possession, and cultivation of marijuana for medicinal purposes in 1996, and 22 states and the District of Columbia have followed suit (Office of National Drug Control Policy, 2015). In addition, 19 states and the District of Columbia have enacted decriminalization laws. Finally, four states and the District of Columbia have legalized marijuana use for adults (>21 years), meaning that there are no criminal sanctions for possession and use (up to a specified amount) (National Conference on State Legislatures, 2015).

Colorado has been an early adopter with regard to liberal marijuana policy. The state passed a medical marijuana amendment in 2000 and—along with Washington State—was the first to permit a legal market for recreational marijuana in 2012 (Winter, 2013). Following a 2009 U.S. Department of Justice directive instructing federal attorneys not to focus resources on prosecuting marijuana cultivators and dispensaries operating in compliance with state laws (i.e., the "Ogden Memo"; Ogden, 2009), the number of licensed medical marijuana dispensaries in Colorado grew rapidly, to greater than 500 in 2013 (Schuermeyer et al., 2014). Since January 1, 2014, adults in Colorado have been able to purchase marijuana for nonmedical use from licensed retail stores. Colorado, then, is an important context for studying adolescent marijuana use because it is at the forefront of changes in marijuana policy and is one of few states with retail marijuana dispensaries.

Alternative modes of marijuana consumption

This is a time of significant technological innovation and commercialization regarding alternative modes of marijuana consumption, particularly in places like Colorado that have legalized marijuana (Budney et al., 2015; Debertin, 2014; MacCoun & Mello, 2015; Schauer et al., 2016; Schroyer, 2015; Walsh, 2013; Weiss, 2015). Specifically, vaporizers and edibles have increased in terms of their sales and their prominence in popular culture (Hopfer, 2014; MacCoun & Mello, 2015; Malouff et al., 2014; Schroyer, 2015). Vaporizers are electronic devices that heat plant matter or marijuana-based oil and release a mist that is then inhaled (Budney et al., 2015; Malouff et al., 2014; Schauer et al., 2016). There has been a recent and substantial proliferation of companies selling different types of vaporizers (Schroyer, 2015). Historically, edibles included foods like brownies and cookies, and were prepared by the consumer. Today, manufacturers mass produce a variety of processed foods, candy, and beverages that are sold in retail shops in several states, including Colorado (MacCoun & Mello, 2015; Wang, 2013; Weiss, 2015). In fact, edible products accounted for 40% of the legal medical and recreational marijuana sales in Colorado in 2014 (Weiss, 2015). Thus, state policies loosening restrictions on the drug have given rise to marijuana dispensaries that sell a host of products and delivery devices for consuming marijuana. The increased diversity and availability of marijuana products may influence the prevalence of use of alternative modes for consuming marijuana among youth.

Current study

Mode of marijuana consumption is not routinely measured in population-based surveys. This is understandable considering the historical predominance of smoking as the mode of consumption. However, given recent trends, it is now important to assess alternative modes of consumption to have a more complete picture of the nature of marijuana use. The purpose of this study was to assess the prevalence of use of specific modes of marijuana consumption among Colorado high school students and to explore how mode of consumption varies by demographic characteristics, substance use behaviors, access, and risk perceptions.

Method

Healthy Kids Colorado Survey

Data come from the high school administration of the Healthy Kids Colorado Survey (HKCS), a biennial survey of Colorado middle and high school students. Data were collected in 2013, before the implementation of retail marijuana but after the implementation of medical marijuana. The methodology for collecting HKCS data is consistent with the Centers for Disease Control and Prevention's Youth Risk Behavior Survey (YRBS), and standard YRBS questions and protocols are used (e.g., quality control measures to detect careless responses) (Brener et al., 2013; Kann et al., 2013). The HKCS uses a two-stage stratified cluster sampling design. For first-stage sampling, a sampling frame of public schools was stratified by Colorado's 21 health statistics regions. Schools were randomly sampled within regions. For second-stage sampling, classrooms were selected, and all stu-

dents within selected classrooms were invited to participate. Schools and classrooms were selected systematically, and all students in the state had a known probability of selection.

Participants completed self-administered, machine-readable questionnaires during a regular class period. Participation was confidential, voluntary, and approved by parents. A total of 106 public schools (79.1%) and 25,197 students (73.6%) participated, for an overall response rate of 58.2%. There were two modules for the HKCS administration, and both had a core set of 63 questions. One of the two modules, Module B, included supplemental questions about marijuana use, including usual mode of consumption, access, perceived harmfulness, and perceived wrongfulness. Half of students (n = 12,526, 49.7%) completed Module B and therefore completed the supplemental marijuana items. This study was approved by the Colorado Multiple Institutional Review Board.

Measures

The HKCS instrument inquired about marijuana, alcohol, and cigarette use, and about modes used to consume marijuana. The item on past 30-day frequency of marijuana use read: "During the past 30 days, how many times did you use marijuana?" and six response options were *never, 1–2 times, 3–9 times, 10–19 times, 20–39 times,* and *40 times or greater.* We derived a "current use" variable that reflected any past 30-day use. There were analogous items for cigarette and alcohol use, and we used the same strategy to derive variables representing current cigarette and alcohol use. We also derived a "frequent marijuana use" variable, which reflected having used 20 times or greater in the past month (i.e., indicating near-daily or daily use). A variable reflecting early onset of use was created based on an item that read, "How old were you when you tried marijuana for the first time?" Respondents who selected younger than age 13 were classified as reporting early use.

We assessed mode of use and how marijuana was accessed. To assess mode of marijuana use, students were asked, "During the past 30 days, how did you most often use marijuana?" and the response options were (a) *I did not use marijuana during the past 30 days,* (b) *I smoked it,* (c) *I ate it (in an edible, candy, tincture, or other food),* (d) *I used a vaporizer,* and (e) *I consumed it in some other way.* To assess how marijuana was accessed, students were asked, "During the past 30 days, how did you usually get the marijuana that you used?" and the response options were (a) *I got it at a public event, such as a party, bar, club, restaurant, concert, or sporting event,* (b) *I got it from someone with a medical marijuana license,* (c) *someone gave it to me,* (d) *I took it from a family member,* (e) *I got it at school,* and (f) *I got it some other way.*

We also examined psychosocial factors that may be associated with marijuana use, including perceived harmful-

ness and perceived wrongfulness. The item on perceived harmfulness read, "How much do you think people risk harming themselves (physically or in other ways) if they use marijuana regularly?" with four response options (i.e., *no risk, slight risk, moderate risk,* and *great risk*). We created a binary response set by collapsing no risk and slight risk ("low perceived risk"), and moderate risk and great risk ("high perceived risk"). To assess perceived wrongfulness, students were asked, "How wrong do you think it is for someone your age to use marijuana?" with four response options (i.e., *very wrong, wrong, a little bit wrong,* and *not wrong at all*). Because of conceptual similarity and for ease of interpretation, we collapsed the four-level response set into two groups, with the former two options representing "high perceived wrongfulness" and the latter two indicating "low perceived wrongfulness."

Demographic characteristics included sex (male, female), grade level (9th–12th), race/ethnicity, and sexual orientation. The race/ethnicity variable for the current study was derived from an item about Hispanic ethnicity (yes, no) and an item about race. Based on responses to those items, respondents were categorized as follows: Hispanic, any race; non-Hispanic American Indian/Alaska Native; non-Hispanic Asian; non-Hispanic Black; non-Hispanic Native Hawaiian or other Pacific Islander; non-Hispanic White; and non-Hispanic Multiracial. The following question was used to assess sexual orientation: "Which of the following best describes you?" The four response options were the following: *heterosexual (straight), gay or lesbian, bisexual,* and *not sure.* Responses were collapsed into one of two categories: (a) heterosexual or (b) lesbian, gay, or bisexual (LGB). Because of a small proportion reporting that they were LGB, we were unable to conduct analyses by type of sexual minority orientation. Those who selected "not sure" were omitted from analyses including sexual orientation because it was not clear whether they fully understood the question (i.e., their response may have reflected a lack of understanding of the question versus an indication that they were questioning their sexuality).

Analyses

We calculated state prevalence estimates and 95% confidence intervals (CIs) for current marijuana use overall among high school students and by (a) demographic factors, (b) risk perceptions, and (c) substance use behaviors. We used Rao–Scott chi-square tests to assess the statistical significance of group differences in current marijuana use (i.e., $p < .05$). The Rao–Scott chi-square test is a widely used design-adjusted test that takes into account the complex sample design and provides estimates that can be applied to the entire study population. For variables with greater than two levels and for which the overall chi-square test was statistically significant, we used Tukey's multiple comparisons

test to compare all possible pairwise differences (Lohr, 2010; Rao & Scott, 1984, 1987).

The remaining analyses were restricted to youth who completed the supplemental module on marijuana and who reported current marijuana use (*n* = 2,637). We conducted unadjusted, multinomial logistic regression models to examine the risk for use of each mode of marijuana consumption overall, and by each of the classification variables, with smoking as the referent group. We also used an unadjusted multinomial logistic regression model to examine reports of how students accessed marijuana by mode of marijuana consumption. Odds ratios (ORs) and 95% CIs are reported.

Sampling weights based on sex, grade, race/ethnicity, and health statistics region were developed. To present estimates that represent the Colorado population of high school youth, we used sampling weights to account for nonresponse and differences in sampling probabilities in all analyses (Brener et al., 2013). Analyses were performed using the complex survey procedures in SAS software package, Version 9.4 (SAS Institute Inc., Cary, NC). For all analyses, estimates were suppressed if the number of subjects in a cell was fewer than 3 and/or if the total number in that category was fewer than 30. All presented percentages and estimates are weighted.

Results

Descriptive statistics for the full sample and for those who completed the supplemental module on marijuana are presented in Table 1. One fifth of Colorado high school youth reported current marijuana use, which varied significantly by demographic factors, risk perceptions, and substance use behaviors (Table 2). Asians had a prevalence of use (10.0%) that was significantly lower than all other race/ethnicity groups. The prevalence of use among White youth, 17.0%, was significantly lower than for Black (25.9%), American Indian/Alaska Native (27.0%), and Multiracial (28.1%) youth. Boys, 11th and 12th graders, and LGB youth were significantly more likely to report current marijuana use than girls, 9th and 10th graders, and heterosexual youth. Those reporting current use of cigarettes or alcohol were also significantly more likely to report marijuana use. Among those who reported "early use" of marijuana (before age 13), 71.6% reported current marijuana use. Thirty-four percent of those with low perceived harmfulness reported current marijuana use, as did 42.2% of those with low perceived wrongfulness.

The most commonly reported usual mode of marijuana consumption was smoking (85.0%), followed distantly by vaporizing (6.2%), ingesting edibles (5.2%), or some other way (3.6%) (Table 3). Smoking marijuana was more commonly cited as the usual mode of use among girls versus boys (89.2% vs. 81.7%) and among those reporting low versus high perceived harmfulness (87.2% vs. 74.5%). The

TABLE 1. Description of sample, Colorado high school students, Healthy Kids Colorado Survey (HKCS), 2013

Variable	Modules A and B combined (*N* = 25,197)	Module B (*n* = 12,526)
Sex		
Female	50.5%	50.3%
Male	49.5%	49.8%
Race/ethnicity		
White	55.3%	54.9%
Hispanic	24.0%	24.5%
Black	3.4%	3.4%
American Indian/Alaska Native	1.5%	1.2%
Asian	3.2%	3.2%
Multiracial	12.1%	12.2%
Native Hawaiian/Pacific Islander	0.6%	0.6%
Grade level		
9th	27.4%	27.1%
10th	26.3%	26.1%
11th	25.5%	26.0%
12th	20.8%	20.8%
Sexual orientation		
Heterosexual	93.8%	93.7%
Lesbian, gay, or bisexual	6.2%	6.4%

Notes: There were two modules for the HKCS administration, and both had a core set of questions. Half of the full sample completed Module B, which included supplemental questions about marijuana use (e.g., mode of consumption, access, perceived harmfulness, and perceived wrongfulness). The 847 who responded "not sure" to the item on sexual orientation are not included in these percentages.

prevalence of smoking as the usual mode of marijuana consumption varied by race/ethnicity, with Asians having the lowest prevalence (74.8%) and Hispanics having the highest (90.0%).

Perceived harmfulness was the only factor associated with a significantly increased likelihood of reporting ingesting edibles as the usual mode of consumption. Those who reported high perceived harmfulness (vs. low) were 2.1 times more likely to report that ingesting edibles was their usual mode of marijuana consumption (8.1% vs. 4.5%, 95% CI [1.3, 3.4]). By contrast, the prevalence of vaporizing as a usual mode of marijuana consumption varied by sex, race/ethnicity, grade, perceived harmfulness, perceived wrongfulness, and current alcohol use (Table 3). Boys were 3.1 times more likely to report vaporizing than girls (95% CI [2.2, 4.5]). The prevalence of vaporizing was particularly high among Asians (20.4%) and Whites (8.6%); Asians were 2.6 times more likely than Whites to report vaporizing (95% CI [1.0, 6.8]). The prevalence of vaporizing increased with grade level; 12th graders were 2.8 times more likely than 9th graders to report vaporizing as their usual mode of marijuana consumption (95% CI [1.5, 5.0]). Youth reporting high (vs. low) perceived harmfulness were 1.9 times more likely to vaporize (95% CI [1.3, 3.0]), whereas those reporting high perceived wrongfulness were less likely to do so (OR = 0.4, 95% CI [0.2, 0.7]).

Compared with Whites, Black and Multiracial youth were significantly more likely to report an unspecified usual mode

TABLE 2.   Current (past 30-day) marijuana use prevalence among Colorado high school students, by selected characteristics—Healthy Kids Colorado Survey, 2013 ($N = 25,197$)

Characteristic	Weighted % [95% CI]	Rao–Scott χ^2, p
Total	19.7 [18.7, 20.6]	–
Sex		15.9, <.0001
Female	17.7 [16.6, 18.8]	
Male	21.5 [20.2, 22.9]	
Race/ethnicity		141.6, <.0001
White	17.0 [15.9, 18.1]	
Hispanic	23.6 [22.1, 25.1]	
Black	25.9 [21.9, 29.9]	
American Indian/Alaska Native	27.0 [21.2, 32.8]	
Asian	10.0 [07.4, 12.5]	
Multiracial	28.1 [25.7, 30.5]	
Native Hawaiian/Pacific Islander	19.4 [11.7, 27.0]	
Grade level		95.8, <.0001
9th	13.7 [12.3, 15.1]	
10th	19.0 [17.7, 20.3]	
11th	22.1 [20.6, 23.6]	
12th	24.3 [22.5, 26.2]	
Sexual orientation		168.7, <.001
Heterosexual	17.7 [16.7, 18.7]	
Lesbian, gay, or bisexual	39.7 [36.5, 42.9]	
Perceived harmfulness of marijuana[a]		1,763.2, <.001
Low	34.4 [32.7, 36.2]	
High	6.4 [5.7, 7.0]	
Perceived wrongfulness of marijuana[a]		4,670.6, <.001
Low	42.2 [40.3, 44.1]	
High	4.1 [3.6, 4.6]	
Early marijuana use (i.e., any use ≤13 years)		3,004.6, <.001
No	15.2 [14.3, 16.0]	
Yes	71.6 [69.3, 73.9]	
Current cigarette use		2,772.6, <.001
No	14.0 [13.2, 14.8]	
Yes	66.5 [64.2, 68.8]	
Current alcohol use		9,226.9, <.001
No	7.3 [6.7, 7.8]	
Yes	45.6 [44.0, 47.2]	

[a]Items were on a supplemental module and were only administered to half of the sample ($n = 12,526$).

of consumption other than smoking, ingesting edibles, or vaporizing (i.e., reported "other"). Being LGB and reporting high perceived harmfulness were also associated with a significantly increased risk for reporting "other" as the usual mode of use. Substance use behaviors were strongly associated with use of reporting other as the usual mode of use: Those reporting frequent marijuana use, early marijuana use, and cigarette use were, respectively, 7.4 times, 7.3 times, and 3.4 times more likely to report "other" as their usual mode of use.

How marijuana was reportedly accessed was associated with usual mode of marijuana consumption (Table 4). Compared with those who were given marijuana by someone, those who accessed marijuana at a public event or who obtained it at school were more likely to report ingesting edibles as their usual mode of use. By contrast, those who accessed marijuana from someone with a medical marijuana card were significantly more likely to report that they usually consume marijuana through vaporizing (OR = 3.4, 95% CI [2.0, 5.6]) or another mode (OR = 4.7, 95% CI [1.8, 12.3]) compared with those who were given marijuana by someone. Last, those who reported obtaining marijuana at school (vs. being given it by someone) were substantially more likely to report usually using another mode of consumption (OR = 15.9, 95% CI [5.3, 47.6]).

Discussion

In this study, we sought to examine the prevalence of usual use of four different modes of marijuana consumption among Colorado high school students: smoking, vaporizing, ingesting edibles, and "other." Our results show that 19.7% of students reported past 30-day marijuana use; this prevalence estimate is comparable to the 2013 national prevalence of high school youth (23.4%) (Johnson et al., 2015), as well as to Monitoring the Future data from 2013, which show that 18% of 10th graders and 22.7% of 12th graders report past 30-day marijuana use (Johnston et al., 2015).

TABLE 3.   Usual mode of consuming marijuana among Colorado high school students reporting past 30-day use, by selected characteristics—Healthy Kids Colorado Survey, 2013 (*n* = 2,637)

Variable	Smoke Weighted % [95% CI]	Ingest Weighted % [95% CI]	Ingest OR [95% CI]	Vaporize Weighted % [95% CI]	Vaporize OR [95% CI]	Other Weighted % [95% CI]	Other OR [95% CI]
Total	85.0 [82.3, 87.7]	5.2 [4.2, 6.2]		6.2 [4.2, 8.2]		3.6 [2.8, 4.5]	
Sex							
Female	89.2 [86.8, 91.7]	4.9 [3.2, 6.5]	Ref.	3.1 [2.0, 4.1]	Ref.	2.8 [1.5, 4.2]	Ref.
Male	81.7 [78.5, 84.8]	5.5 [4.1, 6.9]	1.2 [0.8, 1.9]	8.8 [5.9, 11.6]	3.1 [2.2, 4.5]	4.1 [2.7, 5.4]	1.6 [0.8, 2.9]
Race/ethnicity[a]							
White	82.7 [78.6, 86.7]	6.4 [4.9, 8.0]	Ref.	8.6 [5.4, 11.8]	Ref.	2.3 [1.4, 3.2]	Ref.
Hispanic	90.0 [87.5, 92.6]	3.1 [1.4, 4.9]	0.4 [0.2, 0.9]	3.2 [1.3, 5.0]	0.3 [0.2, 0.7]	3.7 [2.1, 5.3]	1.5 [0.8, 2.8]
Black	80.4 [73.5, 87.3]	6.3 [1.9, 10.6]	1.0 [0.5, 2.2]	4.3 [1.2, 7.5]	0.5 [0.2, 1.2]	9.0 [2.9, 15.0]	4.0 [1.6, 9.8]
American Indian/ Alaska Native	79.4 [60.1, 98.7]	–	–	–	–	–	–
Asian	74.8 [60.2, 89.4]	2.4 [0.0, 4.9]	0.4 [0.1, 1.3]	20.4 [5.6, 35.3]	2.6 [1.0, 6.8]	2.4 [0.4, 4.4]	1.2 [0.5, 2.9]
Multiracial	83.5 [75.5, 91.5]	5.4 [2.0, 8.7]	0.8 [0.4, 1.8]	2.4 [0.6, 4.2]	0.3 [0.1, 0.7]	8.8 [2.3, 15.2]	3.8 [1.6, 8.6]
Grade level							
9th	86.7 [83.0, 90.3]	4.5 [2.1, 6.8]	Ref.	3.7 [2.0, 5.4]	Ref.	5.2 [1.8, 8.5]	Ref.
10th	87.0 [83.6, 90.4]	4.4 [2.8, 6.0]	1.0 [0.6, 1.8]	5.2 [2.5, 8.0]	1.4 [0.7, 2.9]	3.3 [1.8, 4.9]	0.6 [0.3, 1.6]
11th	87.0 [83.8, 90.2]	5.6 [3.4, 7.7]	1.2 [0.7, 2.3]	5.8 [3.7, 7.9]	1.6 [0.8, 2.9]	1.7 [0.4, 2.9]	0.3 [0.1, 0.9]
12th	81.0 [76.0, 86.1]	5.8 [3.9, 7.7]	1.4 [0.7, 2.7]	9.6 [6.1, 13.1]	2.8 [1.5, 5.0]	3.6 [1.5, 5.6]	0.7 [0.3, 2.0]
Sexual orientation							
Heterosexual	87.5 [84.4, 90.5]	4.3 [3.3, 5.4]	Ref.	6.4 [4.1, 8.6]	Ref.	1.9 [1.2, 2.5]	Ref.
LGB	77.4 [68.5, 86.3]	5.7 [2.1, 9.3]	1.5 [0.7, 3.2]	7.4 [2.0, 12.8]	1.3 [0.6, 3.1]	9.5 [4.7, 14.2]	5.8 [3.0, 10.9]
Perceived harmfulness of marijuana							
Low	87.2 [84.7, 89.7]	4.5 [3.6, 5.5]	Ref.	5.6 [3.5, 7.6]	Ref.	2.6 [1.8, 3.5]	Ref.
High	74.5 [68.5, 80.5]	8.1 [5.0, 11.2]	2.1 [1.3, 3.4]	9.3 [5.8, 12.7]	1.9 [1.3, 3.0]	8.1 [4.7, 11.5]	3.6 [1.9, 6.7]
Perceived wrongfulness of marijuana							
Low	85.0 [82.1, 87.8]	4.9 [3.8, 5.9]	Ref.	6.6 [4.5, 8.7]	Ref.	3.6 [2.6, 4.5]	Ref.
High	87.0 [82.0, 92.0]	6.0 [3.0, 9.1]	1.2 [0.7, 2.3]	2.5 [1.1, 3.9]	0.4 [0.2, 0.7]	4.5 [1.4, 7.5]	1.2 [0.6, 2.7]
Early marijuana use							
No	87.2 [84.0, 90.3]	4.6 [3.5, 5.6]		6.9 [4.4, 9.5]	Ref.	1.3 [0.8, 1.8]	Ref.
Yes	81.3 [77.4, 85.2]	5.9 [3.9, 7.9]	1.4 [0.9, 2.1]	3.8 [2.2, 5.3]	0.6 [0.3, 1.0]	9.0 [6.3, 11.7]	7.3 [4.1, 12.8]
Frequent marijuana use							
No	87.2 [84.2, 90.3]	5.3 [4.0, 6.6]	Ref.	6.1 [3.8, 8.3]	Ref.	1.4 [0.9, 2.0]	Ref.
Yes	78.9 [74.1, 83.7]	4.9 [3.0, 6.9]	1.0 [0.6, 1.8]	6.6 [3.8, 9.5]	1.2 [0.7, 2.0]	9.5 [6.6, 12.5]	7.4 [4.2, 13.0]
Current cigarette use							
No	86.4 [83.5, 89.2]	5.2 [3.9, 6.5]	Ref.	6.4 [4.5, 8.4]	Ref.	2.0 [1.2, 2.8]	Ref.
Yes	82.5 [78.3, 86.7]	5.2 [3.6, 6.8]	1.0 [0.7, 1.6]	5.9 [3.0, 8.8]	1.0 [0.6, 1.5]	6.5 [4.2, 8.8]	3.4 [1.9, 6.2]
Current alcohol use							
No	88.8 [85.3, 92.4]	3.8 [2.1, 5.5]	Ref.	4.3 [2.1, 6.4]	Ref.	3.1 [1.6, 4.7]	Ref.
Yes	83.9 [80.8, 87.0]	5.7 [4.4, 7.0]	1.6 [0.9, 2.7]	7.1 [4.8, 9.3]	1.8 [1.1, 2.7]	3.3 [2.3, 4.4]	1.1 [0.6, 2.1]

Notes: Data in this table are estimates among those reporting past 30-day use who completed the supplemental module with additional questions on marijuana use. Odds ratios (ORs) and 95% confidence intervals (CIs) come from a multinomial regression model with smoking as the reference (ref.) group. LGB = Lesbian, gay, or bisexual. [a]For all analyses, estimates were suppressed if the number of subjects was fewer than 3 and/or if the total number in that category was fewer than 30. A dash (–) indicates that there were too few subjects to report estimates. There were too few subjects to report estimates for Native Hawaiian/Pacific Islanders.

Among students reporting past 30-day marijuana use, 85% said smoking was their usual mode of consumption. The remainder reported that their usual mode of consumption was vaporizing (6%), ingesting edibles (5%), or another method (4%). These numbers represent the first estimates of adolescent use of alternative modes of marijuana consumption, and there are no published studies on mode of marijuana consumption among youth for comparison. However, a study of adults showed that modes of consumption that involved combusted marijuana (e.g., joints, bongs, pipes) were most common, a finding consistent with our results (Schauer et al., 2016).

There were noteworthy differences in usual mode of marijuana consumption by sex, race/ethnicity, grade level, substance use, and how marijuana was accessed. Boys, Asians, twelfth graders, and those reporting past 30-day alcohol use were less likely to report smoking and more likely to report vaporizing as their usual mode of consumption. By contrast, girls and Hispanic and Multiracial youth were more likely to report smoking and less likely to report vaporizing as their usual mode of consumption. These findings are consistent with existing research among adults showing that men are more likely than women to use vaporizers (Ramo et al., 2015; Schauer et al., 2016). In addition, students who

TABLE 4. How marijuana was accessed by usual mode of consuming marijuana among Colorado high school students reporting past 30-day use—Healthy Kids Colorado Survey, 2013 (*n* = 2,637)

Variable	Smoke Weighted % [95% CI]	Ingest Weighted % [95% CI]	Ingest OR [95% CI]	Vaporize Weighted % [95% CI]	Vaporize OR [95% CI]	Other Weighted % [95% CI]	Other OR [95% CI]
Public event	79.8 [68.9, 90.8]	12.7 [2.9, 22.4]	3.1 [1.2, 8.3]	5.3 [1.2, 9.5]	1.1 [0.5, 2.8]	2.2 [0.0, 4.3]	2.4 [0.7, 8.2]
From someone with a medical marijuana card	75.2 [67.4, 82.9]	5.8 [2.7, 8.9]	1.5 [0.7, 3.3]	15.0 [7.3, 22.6]	3.4 [2.0, 5.6]	4.0 [1.6, 6.5]	4.7 [1.8, 12.3]
Some other way	87.5 [84.7, 90.3]	4.3 [2.8, 5.8]	1.0 [0.5, 1.7]	3.4 [1.6, 5.1]	0.7 [0.4, 1.2]	4.8 [3.2. 6.4]	4.8 [2.3, 10.3]
Taken by respondent from a family member	77.6 [62.2, 93.0]	5.4 [0.0, 12.6]	1.4 [0.3, 5.7]	4.5 [1.2, 7.7]	1.0 [0.4, 2.2]	–	–
Obtained at school	68.3 [56.3, 80.3]	11.0 [2.5, 19.5]	3.1 [1.1, 9.0]	8.4 [2.4, 14.3]	2.1 [0.9, 5.1]	12.4 [2.8, 21.9]	15.9 [5.3, 47.6]
Given to respondent by someone	89.2 [86.2, 92.2]	4.6 [2.6, 6.5]	Ref.	5.2 [3.6, 6.9]	Ref.	1.0 [0.3, 1.7]	Ref.

Notes: Data in this table are estimates among those reporting past 30-day use who completed the supplemental module with additional questions on marijuana use. Odds ratios (ORs) and 95% confidence intervals (CIs) come from a multinomial regression model with smoking as the reference (ref.) group. A dash (–) indicates that there were too few subjects to report estimates.

reported frequent marijuana use (i.e., >20 times in the past 30 days) were significantly less likely to report smoking as their usual mode of marijuana consumption. There were minor differences in ingesting edibles by demographic and substance use characteristics. Compared with those who had been given marijuana by someone, those who accessed marijuana at a public event, from someone with a medical marijuana card, or who obtained it at school were more likely to report their usual mode of use was ingesting edibles, vaporizing, or another mode.

Students reporting high levels of perceived harmfulness—that is, who believed that regular use of marijuana was associated with moderate or great risk—were significantly less likely to report smoking as their usual mode of consumption and were significantly more likely to report that it was ingesting edibles, vaporizing, or another mode. This finding suggests that youth may perceive vaporizing or ingesting edibles as less harmful than smoking marijuana, possibly because of exposure to public health messages about the harms of cigarette smoking. Young people may be using alternative methods of marijuana consumption in an attempt to reduce perceived harms associated with smoking (Budney et al., 2015). To better assess perceived harmfulness and its association with mode of marijuana consumption, in future research it may be worthwhile to inquire about perceived harm associated with smoking marijuana specifically, rather than about using marijuana more broadly. Such research may show that youth have higher levels of perceived harmfulness regarding smoking marijuana compared with ingesting edibles or using vaporizers.

There were notable differences by demographic and substance use variables in reporting unspecified "other" as the usual mode of marijuana consumption. Black, Multiracial, and LGB youth were significantly more likely report "other" as their usual mode of consumption, as were those reporting early marijuana use (i.e., use before age 13), frequent

marijuana use (i.e., used >20 times in the past 30 days), and cigarette smoking. Because blunt use (i.e., smoking marijuana using a hollowed-out cigar) is more common among Blacks, those who report cigarette smoking, and those with a cannabis use disorder (Fairman, 2015; Golub, 2006; Soldz et al., 2003), some youth reporting "other" as their usual mode of consumption may have been referring to blunt use (i.e., they may consider blunt use as distinct from smoking marijuana). Future studies could provide clarity about other modes of use by inviting participants to specify the modes they are referring to. Doing so would also allow researchers to have a more comprehensive understanding of additional modes of marijuana consumption that may be growing in popularity, such as "dabbing" (i.e., heating a high potency cannabis extract against a metal surface and inhaling the vapor) (Loflin & Earleywine, 2014; Stogner & Miller, 2015).

Limitations

Results should be viewed within the context of important limitations. First, HKCS data are collected via self-report, and respondents may misreport their marijuana use. Survey administrators have undertaken several strategies to reduce reporting bias, including having instructions that emphasize the confidential nature of responses (Brener et al., 2013). The lack of parental proximity during school-based survey administration likely promotes more accurate reporting of illegal or underage drug use by youth (Kann et al., 2014; Substance Abuse and Mental Health Services Administration, 2012). Second, HKCS is completed by youth who attend school and is therefore not representative of all adolescents. Because 95% of 16- to 17-year-olds do attend school (Chapman et al., 2011), the group not represented is small. However, because youth who leave school permanently or skip school on the day of the survey are more likely to engage in substance use (Bray et al., 2000; Roebuck

et al., 2004), current results may underrepresent marijuana use prevalence among high school–aged youth. Third, the HKCS data set does not include a large enough number of American Indian/Alaska Native or Native Hawaiian/Pacific Islander students to provide reliable estimates of modes of marijuana use. Targeted research on those groups may be warranted. Last, these data are from Colorado, and results may not be generalizable to youth in other states or states with dissimilar marijuana policies.

As a final point, results should be considered in light of how the item on mode of marijuana use was designed. It inquires about the mode that was used most often, rather than about any use of the particular mode. Therefore, the reported prevalences of use for vaporizing and ingesting edibles are almost certainly underestimates, because a person who reports smoking as their usual mode may also vaporize or ingest edibles occasionally. To obtain more precise estimates of modes of consumption, future studies should assess "any use" of specific modes in addition to the usual mode of consumption.

Conclusions

It is crucial to fully identify and track patterns of adolescent marijuana use to identify how changes in marijuana policies across the United States may affect future use. Our work shows that 15% of Colorado high school students who use marijuana report that they usually use a mode of consumption other than smoking. Usual mode of consumption varies by demographic factors, psychosocial factors, and substance use behaviors. These data were collected shortly before retail marijuana was established in Colorado, and these results can be considered baseline estimates. Continued research will shed light on how patterns of marijuana use are changing among adolescents.

Acknowledgments

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