Journal of Adolescent Health xxx (2019) 1–8

ELSEVIER

JOURNAL OF ADOLESCENT HEALTH

www.jahonline.org

Original article

Exposure to Cannabis Marketing in Social and Traditional Media and Past-Year Use Among Adolescents in States With Legal Retail Cannabis

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Article history: Received March 24, 2019; Accepted August 19, 2019
Keywords: Adolescents; Cannabis; Social media; Marketing

A B S T R A C T

Purpose: The objective of this study was to examine adolescents' self-reported exposure to cannabis marketing in states with legalized cannabis and its association with past-year cannabis use.
Methods: We conducted a cross-sectional, online panel survey of 469 adolescents aged 15–19 years residing in four states with legal retail cannabis for adult use. Adolescents self-reported exposure to cannabis marketing on social or traditional media (i.e., outdoor or print) and past-year cannabis use. Logistic regression generated estimated odds of youths' past-year cannabis use by marketing exposure after adjusting for demographic factors and cannabis-related social norms.
Results: Exposure to cannabis marketing on Facebook, Twitter, and Instagram was associated with increased odds of past-year cannabis use of 96% (95% confidence interval [CI]: 15%–234%), 88% (95% CI: 11%–219%), and 129% (95% CI: 32%–287%), respectively. Odds of past-year cannabis use increased by 48% (95% CI: 16%–87%) with each additional social media platform where adolescents reported exposure.
Conclusions: Despite restrictions that prohibit cannabis advertising on social media, adolescents are exposed to cannabis marketing via social media, and this exposure is associated with recent cannabis use. States should consider further regulation of cannabis marketing on social media.

IMPLICATIONS AND CONTRIBUTION

Adolescents in states with legal retail cannabis are exposed to cannabis marketing on social media. Exposure to such marketing via Instagram, Facebook and Twitter was associated with past-year cannabis use. Additional research is warranted, and policymakers should consider further regulation of cannabis marketing on social media.

Cannabis (marijuana) use is common among adolescents in the United States (U.S.) [1]. Youth who initiate cannabis use at earlier ages are at higher risk of developing cannabis use disorders or cannabis dependence than those who start later [2,3]. Regular cannabis use in adolescence is associated with decreased cognitive function, poor academic performance, and other drug use [4,5]. Adolescents who drive after using cannabis may be at increased risk of motor vehicle crash involvement [6].

Conflicts of interest: The authors have no conflicts of interest to disclose.
Disclaimer: The content is solely the responsibility of the authors and does not necessarily represent the official view of the National Institute on Drug Abuse, National Institute on Alcohol Abuse and Alcoholism, or the National Institutes of Health.

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1054-139X/
https://doi.org/10.1016/j.jadohealth.2019.08.024

As of August 2019, 11 U.S. states have legalized cannabis for general (i.e., recreational) use by adults older than 21 years [7]. In most of these states, drug policy reform organizations successfully led ballot initiatives to legalize, regulate, and tax cannabis similar to alcohol [8]. From a public health perspective, using alcohol as a regulatory model is concerning [9] because underage drinking remains common and alcohol continues to play a substantial role in injury, deaths, and other adverse health consequences among adolescents [10,11]. Nonetheless, retail cannabis shops are open in seven states, and the U.S. cannabis market was valued at $10.4 billion in 2018 with expectation of continued growth [12]. One aspect of this new legal cannabis marketplace that is relatively understudied is exposure to cannabis marketing.

Marketing has been defined as "any commercial communication or other activity, including advertising, promotion, and sponsorship, that is designed to increase the recognition, appeal, and/or consumption" of the product being marketed [13]. This includes both direct advertising (e.g., paid messages) and indirect promotions (e.g., events, giveaways, discounts, etc.). Yet because of cannabis' status as a schedule one substance under the federal Controlled Substances Act, many marketing activities used for other products or substances are banned, particularly if they cross state lines. The same is true of direct advertising for cannabis on most major social media platforms [14]. However, cannabis businesses may establish a social media profile to represent their brand and create posts that are seen by followers of that page. If these business profiles post about cannabis, this content may not fall under the platforms' restrictions on direct advertising. Thus, adolescents may access and potentially engage with cannabis companies via profiles established by these businesses. [15].

Relatively little is known about the relationship between adolescents' exposure to cannabis marketing and cannabis use, but decades of research on alcohol and tobacco—other legal substances with abuse potential—show strong correlations between youth exposure to marketing and both earlier initiation and higher consumption among those already using [16,17]. This suggests that exposure to cannabis marketing could have a similar relationship with cannabis use behaviors.

Exposure to cannabis-promoting content on social media is of particular concern because nearly all teens use some form of social media (e.g., Instagram, Facebook, Twitter), and 45% report being online "almost constantly" [18]. Data from the 2014 and 2015 iterations of a nationally representative survey of high-school students showed that just more than half of adolescents reported exposure to cannabis advertising on the Internet, and this exposure was associated with greater odds of recent cannabis use and more frequent use [19]. However, this study did not differentiate between cannabis advertising on social media or via other Internet sources. Longitudinal data from California—where medical marijuana has been legal since 1996—showed adolescents' exposure to medical cannabis advertising (in billboards, magazines, or somewhere else) has increased over time [20]. Adolescents with higher than average exposure reported more frequent cannabis use, stronger intentions to use cannabis in the future, more positive expectancies about cannabis use, and more negative consequences from cannabis use [20]. Several studies have documented that adults report exposure to cannabis marketing online, including on social media [21–23], but the extent to which that is true for adolescents is unknown.

Emerging research among adolescents supports applying constructs from the theory of normative social behavior to help explain the pathway between exposure to marketing and cannabis use behavior. Pro-cannabis injunctive norms (i.e., perceptions of others' approval of a behavior) have been found to be predictive of cannabis use in university students [24]. The theory of normative social behavior suggests that behaviors, including substance use behaviors, are shaped by injunctive norms [25,26] and outcome expectations (i.e., beliefs about the consequences of a behavior) [27]. Exposure to cannabis promotions via social media could influence adolescents' cannabis use by helping to shape injunctive norms, suggesting high levels of peer approval of cannabis use and/or by creating or reinforcing positive outcome expectations. Exposure to cannabis-promoting content on social media may be particularly influential on adolescent behavior if that content is liked or shared by peers.

States differ in their restrictions on cannabis marketing. With respect to youth, states prescribe restrictions on cannabis marketing placement and content. In terms of placement, Colorado established its cannabis marketing policies based on the alcohol industry's voluntary code, which requires companies not to advertise in outlets (i.e., television, radio, print, and the Internet) in which more than 30% of the audience can be "reasonably" expected to be younger than 21 years. A similar standard has been transferred, with different degrees of specification, to seven other states with legal retail cannabis markets.

This standard as applied to alcohol has been the subject of substantial criticism from both policymakers and alcohol researchers [28,29] Youth who are most at risk of initiating alcohol use are aged between 12 and 20 years; this group comprises closer to 15% of the U.S. population [28]. A 30% standard allows this group to be targeted much more heavily than their presence in the population would warrant, and studies of youth exposure to alcohol marketing have consistently documented this disproportionate exposure [30,31]. It is concerning that this standard is, nonetheless, being applied in the context of cannabis legalization. Cannabis marketing regulations also include minimum distance standards for places frequented by children (e.g., schools). In addition, some states prohibit cannabis marketing content that targets youth; however, experience with alcohol advertising self-regulatory codes have shown that such content standards are ineffective at shielding youth from content attractive to them [30].

This study sought to address the gap in knowledge about the extent to which adolescents are exposed to cannabis marketing via both social and traditional media platforms. Using cross-sectional data, we examined whether cannabis marketing exposure was associated with past-year cannabis use after controlling for known risk factors, such as older age, male gender [1,32], pro-cannabis injunctive norms, and positive expectancies [33]. In particular, we investigated exposure to cannabis advertising or promotions via three popular social media platforms (Facebook, Twitter, and Instagram) as well as two traditional platforms (outdoor billboards and print media) in four states with legalized retail cannabis. In addition, we explored the relationship between cannabis use and exposure to cannabis marketing via multiple platforms.

Methods

In February 2018, we conducted a survey using an online panel (Qualtrics, Provo, UT) of English-speaking adolescents aged 15–19 years residing in four states with legal nonmedical cannabis (California, Colorado, Nevada, and Washington). All

sampled states had implemented medical or general adult use cannabis sales for at least one year before our data collection.

Qualtrics recruits panelists using online advertisements (e.g., on social media or in apps), inviting survey participation as a way to earn credit toward rewards such as gift cards, in-app purchases, or airline miles. A background check is conducted to verify identity before the participant becomes part of a panel and eligible for recruitment. Surveys deployed via Qualtrics panels typically demonstrate demographic characteristics that fall within a 10% range of the values observed in the U.S. population [34].

Qualtrics sent survey invitations to existing panel members who were parents of youth aged 15–17 years and to adults aged 18 or 19 years. The sample was designed to be balanced between younger (15–17 years) and older (18–19 years) adolescents. A simple recruitment message was emailed to potentially eligible individuals notifying them of a survey opportunity, describing the estimated survey length (15 minutes), and informing them that up to approximately $20 in e-rewards credit could be obtained in return for participation. All adult participants provided informed consent, and minor participants provided informed assent and their legally authorized guardians provided parental consent. Minor participants were instructed to complete the survey independently in a private location. Forty-six percent of individuals who initiated the survey screening items did not consent to participate or were outside the target age range. The Institutional Review Board at the University of Wisconsin-Madison approved this study.

Measures

Demographics. We categorized age into middle adolescence (age, 15–17 years) and older adolescence (age, 18–19 years). Gender was measured using three categories: female, male, and other. We combined separate survey questions on race and ethnicity into one categorical variable: white/Caucasian, black/African American, Hispanic/Latino, and other. Parent education was measured using five categories: less than high-school diploma, high-school diploma, some college or associate degree, bachelor's degree, or advanced degree.

Social media use. Participants' social media use patterns were ascertained by asking "Which of the following social media platforms do you use?" with a multiple response option that allowed participants to indicate whether or not they use Facebook, Instagram, Twitter, or other platforms.

Cannabis use. Lifetime cannabis use was ascertained. The survey provided the term marijuana as well as cannabis at first mention of the drug and was pilot-tested with adolescents to ensure comprehension. Adolescents who reported any lifetime cannabis use were asked about past-year use with the following question: "What types of cannabis have you used in the past 12 months?" Youth could select more than one response from choices including cannabis (plant), concentrates/extracts, edibles, other, and "I have not used cannabis in the past 12 months." We recoded this item. so "I have not used cannabis in the past 12 months" and lifetime nonusers were coded as having no past-year cannabis use (0) and all other options were coded as yes (1).

Exposure to cannabis marketing. Participants self-reported their frequency of exposure to cannabis marketing on three social media platforms (Facebook, Twitter, and Instagram) and via two traditional platforms (newspapers/magazines and outdoor). Questions were adapted from the National Youth Tobacco Survey [35] and used the following structure: "When you are using [PLATFORM], how often do you see ads or promotions for cannabis or related products?" Response options were coded on a 5-point Likert scale (never, rarely, sometimes, most of the time, always), and respondents had the option to report they do not use each particular platform. We recoded these variables into a binary (yes/no) format where rarely, sometimes, most of the time, and always were coded as yes (1). Never and I do not use [PLATFORM] were coded as no (0).

For traditional media platforms, we asked participants to report exposure to outdoor advertising with the question "In the past 30 days, how often did you see any ads or promotions for cannabis or related products that were outdoors on a billboard or could be seen from outside a store?" We also asked "When you read newspapers or magazines (online or in print), how often do you see ads or promotions for cannabis or related products?" The same 5-point Likert scale response (i.e., never to always) and approach to dichotomization (yes/no) as described previously was used for these items. These items were also adapted from the National Youth Tobacco Survey [36].

We calculated a count of the number of platforms with cannabis marketing exposure by summing the respective binary variables. We did this three times, counting exposure across social media platforms (i.e., Facebook, Twitter, and Instagram), traditional media platforms (i.e., outdoor advertising and newspapers/magazines), and all platforms.

The theory of normative social behavior

Injunctive norms. The injunctive norms questions used a five-point Likert scale for participants to rate how much they agreed (strongly agree to strongly disagree) with statements on the appropriateness of people of their age consuming cannabis every weekend. Youth first provided their own perception of appropriateness and then gave their perception of society's perceived appropriateness in general. We averaged these items to form a measure of the extent to which youth felt cannabis use was acceptable.

Outcome expectations. The outcome expectation scale contained six items ascertaining the participants' perception of what would happen after someone used cannabis. There were three positive items (e.g., cannabis helps you relax and feel less tense) and three negative items (e.g., cannabis makes it harder to think and do things). We reverse scored the negative items and calculated an average. The resulting outcome expectations variable can be interpreted as the extent to which youth expected more positive or fewer negative consequences from cannabis use.

Analyses

Exploratory data analysis included frequencies, chi-squared tests of association, and t-tests assuming unequal variance. We also centered the outcome expectation variable. Because cannabis use and motivations for use may differ by gender, we examined this by including a gender*outcome expectation interaction term. We used logistic regression with robust standard errors to determine the association between cannabis marketing exposure and past-year cannabis use after adjusting for demographics, injunctive norms, outcome expectations, and

group identity. Model specification was assessed using specification link tests, and model fit was assessed using Hosmer Lemeshow's goodness of fit test. All models had appropriate specifications and fits. We used standardized residuals, deviance, and leverage to identify potential outliers and influential points. In the end, we determined that no data points had undue influence, and all observations remained in the analysis.

Results

The analytic sample included 469 participants (70% female, 26% male, and 4% other) after excluding 28 youth with missing data on cannabis use or demographic factors (Table 1). A majority of participants (61%) were from California, with 13.6% from Colorado, 7.9% from Nevada, and 17.9% from the State of Washington. All adolescents in the sample reported using at least one social media platform.

Most adolescents (93.6%) in the sample reported some form of exposure to cannabis marketing (Table 2). A majority of adolescents reported seeing cannabis marketing on at least one social media platform, with a higher proportion of past-year cannabis users reporting exposure (89.6%) than nonusers (74.0%; $p < .001$). Of the three social media platforms examined, the proportion of adolescents reporting exposure to marketing via Facebook was highest, and more past-year cannabis users reported exposure on Facebook (72.4%) than those who did not use cannabis in the past year (52.5%, $p < .001$). Of the traditional platforms, exposure to outdoor advertising (e.g., billboards) was more common (72.9%) than exposure via newspapers or magazines (43.1%). A higher proportion of cannabis users (79.9%) reported exposure to outdoor advertising than nonusers (70.1%; $p = .033$). Cannabis marketing exposure on Instagram was higher for blacks than for other racial/ethnic groups and on Facebook and Twitter for older adolescents versus younger adolescents, but no other differences in exposure were observed by demographic variables (Supplemental Table S1).

When controlling for demographic factors, injunctive norms about cannabis use, cannabis outcome expectancies, and the interaction between gender and cannabis outcome expectancies, we found that past-year cannabis use was positively associated with perceived exposure to cannabis marketing. The increase was highest for Instagram (odds ratio [OR] = 2.29; 95% confidence interval [CI]: 1.32–3.97), followed by Facebook (OR = 1.96; 95% CI: 1.15–3.34), and Twitter (OR = 1.88; 95% CI: 1.11–3.19) (Table 3). There were no associations between exposure to cannabis advertising outdoors (e.g., billboards) or via newspapers/magazines and past-year cannabis use (Supplemental Table S2).

When looking at cumulative exposure across the five platforms, there was a 26% (CI: 09%–45%) increase in the odds of past-year use associated with each additional media platform on which adolescents were exposed to cannabis marketing, controlling for possible confounders (Table 4). Among the three social media platforms, there was a 48% (CI: 16%–87%) increase in the adjusted odds of past-year cannabis use associated with each additional platform on which adolescents viewed cannabis marketing.

Discussion

In this sample of adolescents from four states with retail cannabis, nearly all adolescents reported perceived exposure to cannabis marketing. This is similar to findings from California

Table 1
Sample demographic and background characteristics

	Used cannabis in the past year				Total		
	No (n = 335)		Yes (n = 134)		(n = 469)		*p*-value
	n	%	n	%	n	%	
Age							.050
15–16 years	176	52.5	57	42.5	233	49.7	
17–19 years	159	47.5	77	57.5	236	50.3	
Gender							.721
Female	232	69.3	97	72.4	329	70.1	
Male	92	27.5	32	23.9	124	26.4	
Other	11	3.3	5	3.7	16	3.4	
Race/Ethnicity							.602
White	118	35.2	52	38.8	170	36.2	
Black	21	6.3	10	7.5	31	6.6	
Hispanic/Latino	132	39.4	53	39.6	185	39.4	
Other	64	19.1	19	14.2	83	17.7	
Parent's highest grade completed							.176
Less than HS	71	21.2	23	17.2	94	20.0	
HS or GED	117	34.9	59	44.0	176	37.5	
Some college or higher	147	43.9	52	38.8	199	42.4	
State of residential address							.143
California	210	62.7	74	55.2	284	60.6	
Colorado	47	14.0	17	12.7	64	13.6	
Nevada	21	6.3	16	11.9	37	7.9	
Washington	57	17.0	27	20.1	84	17.9	
Media use habits							
Use of Facebook	241	71.9	111	82.8	352	75.1	.014
Use of Twitter	186	55.5	84	62.7	270	57.6	.156
Use of Instagram	278	83.0	123	91.8	401	85.5	.014
Frequency of social media use							.543
Never	1	.3	0	.0	1	.2	
Monthly	8	2.4	1	.7	9	1.9	
A few times a month	2	.6	1	.7	3	.6	
Weekly	3	.9	1	.7	4	.9	
A few times a week	25	7.5	5	3.7	30	6.4	
Once a day	29	8.7	9	6.7	38	8.1	
More than once a day	267	79.7	117	87.3	384	81.9	
Daily social media use (n = 441 daily users)							.342
Less than 30 minutes per day	126	41.2	58	43.0	184	41.7	
30–60 minutes per day	79	25.8	37	27.4	116	26.3	
1–2 hours per day	54	17.6	19	14.1	73	16.6	
2–4 hours per day	27	8.8	10	7.4	37	8.4	
4+ hours per day	8	2.6	2	1.5	10	2.3	

p-value from chi-square tests.
GED = general educational development; HS = high school.

Table 2
Prevalence of exposure to cannabis marketing among adolescents, by platform

	Used cannabis in the past year				Total		*p*-value
	No (n = 335)		Yes (n = 134)		n = 469		
	n	%	n	%	n	%	
Exposure to cannabis advertising/promotions via							
Any platform	309	92.2	130	97.0	439	93.6	.056
Any social media platform	248	74.0	120	89.6	368	78.5	<.001
Facebook	176	52.5	97	72.4	273	58.2	<.001
Twitter	122	36.4	68	50.7	190	40.5	.004
Instagram	196	58.5	102	76.1	298	63.5	<.001
Newspapers/magazines	137	40.9	65	48.5	202	43.1	.133
Outdoors (e.g. billboards)	235	70.1	107	79.9	342	72.9	.033

p-value from chi-square tests.

Table 3
Multivariable associations between exposure to cannabis marketing on social media and past-year cannabis use

	OR	Facebook, 95% CI	*p*-value	OR	Twitter, 95% CI	*p*-value	OR	Instagram, 95% CI	*p*-value
Exposure to promotions on Facebook									
No (reference group)									
Yes	**1.96**	**(1.15–3.34)**	**.013**						
Exposure to promotions on Twitter									
No (reference group)									
Yes				**1.88**	**(1.11–3.19)**	**.018**			
Exposure to promotions on Instagram									
No (reference group)									
Yes							**2.29**	**(1.32–3.97)**	**.003**
Age category									
Mid-adolesence (reference group)									
Older adolesence	.74	(.42–1.30)	.298	.74	(.42–1.31)	.305	.84	(.48–1.48)	.553
Gender									
Female (reference group)									
Male	1.30	(.70–2.41)	.401	1.32	(.71–2.47)	.383	1.35	(.73–2.52)	.343
Other	1.26	(.41–3.82)	.686	1.51	(.44–5.10)	.511	1.29	(.39–4.34)	.678
Race/ethnicity									
White (reference group)									
Black	1.25	(.32–4.92)	.75	1.22	(.30–4.93)	.782	1.17	(.29–4.69)	.832
Hispanic/Latino	.87	(.50–1.54)	.641	.86	(.49–1.51)	.599	.84	(.47–1.49)	.524
Other	.55	(.26–1.17)	.120	.53	(.25–1.13)	.102	.54	(.25–1.16)	.115
Parent education									
Less than high school (reference group)									
HS or GED	2.26	(1.13–4.54)	.021	2.19	(1.10–4.32)	.025	2.33	(1.17–4.63)	.016
Completed some college or more	1.73	(.85–3.52)	.131	1.61	(.81–3.23)	.177	1.77	(.87–3.58)	.113
Theory of normative social behavior									
Injunctive norms	**1.74**	**(1.40–2.17)**	**<.001**	**1.71**	**(1.37–2.13)**	**<.001**	**1.73**	**(1.38–2.16)**	**<.001**
Outcome expectancies score	**63.83**	**(14.31–284.82)**	**<.001**	**76.80**	**(15.38–383.51)**	**<.001**	**63.34**	**(14.65–273.86)**	**<.001**
Gender X outcome expectancies	**.24**	**(.11–.56)**	**.001**	**.23**	**(.09–.57)**	**.001**	**.25**	**(.11–.58)**	**.001**

Bold values represent statistically significant values at alpha .05.
CI = confidence interval; GED = general educational development; HS = high school; OR = odds ratio.

youth [20]. In a novel contribution to the literature, we found that the prevalence of reported exposure to cannabis marketing on social media was high, despite the fact that direct cannabis advertising is prohibited on those platforms. More than three-quarters of youth reported being exposed to cannabis marketing via social media, a proportion 5% higher than those who

Table 4
Cumulative exposure to cannabis marketing and past-year cannabis use

	OR	All platforms	*p*-value	Social media platforms			Traditional media platforms		
		95% CI		OR	95% CI	*p*-value	OR	95% CI	*p*-value
No. of platforms*	**1.26**	**(1.09–1.45)**	**.002**						
No. of social media platforms*				**1.48**	**(1.16–1.87)**	**.001**			
No. of traditional media platforms*							1.23	(.98–1.54)	.078
Age category									
Mid-adolescence									
Older adolescence	.75	(.43–1.33)	.325	.76	(.43–1.33)	.339	.78	(.45–1.37)	.391
Gender									
Female (reference group)									
Male	1.29	(.69–2.40)	.421	1.35	(.72–2.52)	.352	1.26	(.68–2.33)	.459
Other	1.38	(.40–4.77)	.608	1.44	(.44–4.68)	.549	1.30	(.38–4.47)	.678
Race/ethnicity									
White (reference group)									
Black	1.19	(.28–5.10)	.814	1.09	(.26–4.61)	.906	1.35	(.34–5.30)	.667
Hispanic/Latino	.88	(.50–1.56)	.662	.87	(.49–1.54)	.636	.86	(.49–1.53)	.615
Other	.54	(.26–1.14)	.107	.53	(.24–1.13)	.099	.55	(.26–1.16)	.144
Parent education									
Less than high school (reference group)									
HS or GED	**2.35**	**(1.17–4.73)**	**.017**	**2.29**	**(1.14–4.58)**	**.019**	**2.3**	**(1.15–4.58)**	**.018**
Completed some college or more	1.71	(.84–3.47)	.139	1.71	(.84–3.48)	.139	1.66	(.82–3.35)	.156
Theory of normative social behavior									
Injunctive norms	**1.73**	**(1.38–2.16)**	**<.001**	**1.70**	**(1.36–2.11)**	**<.001**	**1.77**	**(1.41–2.22)**	**<.001**
Outcome expectancies score	**67.8**	**(14.11–325.84)**	**<.001**	**76.88**	**(16.33–362.03)**	**<.001**	**57.83**	**(12.61–265.14)**	**<.001**
Gender X outcome expectancies	**.24**	**(.01–.09)**	**.002**	**.22**	**(.09–.53)**	**.001**	**.26**	**(.11–.63)**	**.003**

Bold values represent statistically significant values at alpha .05.
CI = confidence interval; GED = general educational development; HS = high school; OR = adjusted odds ratio.

* Odds ratio represents increase in odds of past-year cannabis use associated with a 1-unit increase in the number of platforms via which the participant observed cannabis advertising or promotions. Five platforms were measured: three social media platforms (Facebook, Twitter, and Instagram) and two traditional media platforms (outdoor and newspaper/magazines).

reported exposure via outdoor advertising. Outdoor advertising offers minimal control over who views it; teens and young children who are driven by their parents on a public highway with a cannabis billboard will encounter this advertising just as often as adults who travel the same path. It is concerning that teens may be seeing even higher levels of cannabis marketing on social media where it can be highly interactive and influential and where, theoretically, there is greater potential for control over viewership.

Our study found few differences in exposure by demographic factors, but it is notable that black youth reported a disproportionately high level of cannabis marketing exposure on Instagram. We observed higher odds of past-year cannabis use among youth who reported exposure to cannabis marketing on social media, even after controlling for demographics and normative factors that influence cannabis use. This is in line with research on alcohol and tobacco, showing that youth with greater exposure to marketing are more likely to use or increase their use of these products, particularly when that exposure involves participation in the marketing [37], which is precisely what social media facilitates through features such as liking and sharing.

The strength of the association with past-year cannabis use was highest for exposure to cannabis marketing on Instagram, followed by Facebook and then Twitter. This may be reflective of the fact that Instagram has grown in popularity as a social media platform among adolescents [38]. Each additional social media platform through which adolescents were exposed to cannabis marketing was associated with increased odds of past-year cannabis use.

Of the states included in this study, Colorado, Nevada, and California specifically prohibit cannabis retailers from marketing on media platforms where more than about 30% of the audience is expected to be younger than 21 years. The State of Washington advises cannabis businesses to "use social media with caution and to be mindful not to appeal to, or solicit, viewers younger than 21 years. If possible, please restrict views to adults aged 21 years and older" [39]. Despite these guidelines and restrictions and despite the federal prohibition of cannabis use, our data demonstrate that cannabis promotions are currently reaching most adolescents.

Given the potential negative consequences of adolescent cannabis use and social media's possible role in this use, states should consider substantial restrictions on marketing. In line with the cannabis policy framework laid out by the Canadian Centre for Addiction and Mental Health, we suggest states consider banning all marketing of cannabis products [40]. This would be representative of a public health approach that draws upon the evidence in the related area of tobacco regulation; prevalence of smoking among adolescents has generally decreased in locations that banned tobacco marketing [41]. It is also what has been recommended by the Pan American Health Organization for alcohol marketing if such a ban is constitutionally feasible [13]; because cannabis is still illegal at the federal level, states have more leeway to consider a full ban on cannabis marketing than they do for alcohol marketing.

If a full ban cannot be enacted, there are several other actions that states could consider: (1) reducing the audience composition threshold for the proportion of underage individuals in venues where cannabis is advertised, directly or indirectly, from 30% to 10%–15%, to be in line with the proportion of youth aged 12–20 years in the general population [28]; (2) requiring cannabis marketers to supply marketing expenditure data on a regular basis, including amounts spent on advertising, price discounting and incentives, promotional allowances, payments to retailers and wholesalers, and contributions to elected officials [42], as well as data on where ads are being placed and best available demographic information about audiences being reached [31,43]; (3) establishing well-researched and well-funded counter-marketing campaigns that deliver public health messages; (4) removing the tax deductibility of cannabis advertising and marketing expenditures at the state level to effectively increase the costs of these activities; and (5) funding research to evaluate the impacts of different cannabis marketing policies on adolescent cannabis use, problematic use, and dependence.

There are additional challenges to consider when trying to prevent youth exposure to cannabis marketing. Although paid cannabis advertisements purchased and placed through the social media platforms' advertising portals are prohibited, unpaid promotions are exempt from these policies. The policies also do not keep individuals from seeking out such content via business pages or encountering it when shared by others in their social network. It will be important for future studies to document and understand the impact of passive exposure to cannabis promotions versus cannabis content-seeking behavior, either on social media sites or on cannabis-specific websites (e.g., Weedmaps, Leafly). Additional research is also needed into whether algorithms used by social media platforms are targeting cannabis-related content to underage individuals or specific demographic groups.

Limitations

There are several limitations to this study. First, we examined cannabis marketing exposure through three primary social media platforms, but there are others (e.g., SnapChat, YouTube) and cannabis-specific platforms where cannabis marketing exposure may occur.

Second, the cross-sectional design does not permit us to draw conclusions about directionality of the observed associations or conclude that the associations are causal. Indeed, adolescents who use cannabis may also seek out cannabis-promoting content. Evidence of this inverse relationship between cannabis use and increased exposure to marketing was found in a longitudinal study demonstrating that California youth reporting higher levels of cannabis use at one time point also reported more medical cannabis advertising exposure one year later [20,44].

Third, there are some potential sources of bias. Response bias could be a threat if lower income individuals were more likely to take the survey than those with higher incomes, given that an incentive was offered. We did not ascertain household income, so we could not assess the extent to which this may have affected these data. Social desirability bias can also be a threat in self-reported data such as these if subjects underreport illegal behaviors. We believe this does not substantially threaten validity of this study because the prevalence of past-year cannabis use in our sample was similar to national estimates obtained via traditional survey methods. [1] Recall bias could also be an issue if cannabis-using youth had different recall of marketing exposure than nonusers. In addition, misclassification bias could be a concern if youth did not accurately discern between formal promotions from cannabis businesses and user-generated content, which could result in an overestimation of exposure to cannabis promotions.

Fourth, our power to conduct stratified analyses and detect differences within subgroups was limited by the sample size.

Finally, the nonprobability sample was not designed for representativeness of adolescents in the U.S. or of the states with legal retail cannabis. Females were overrepresented in the sample, but our regression analyses controlled for gender which helps to mitigate any bias from this imbalance. Our sample was also not balanced across the four included states; adolescents from California comprised more than half of the sample. This is likely due to California having a much larger population than the other three states. Given this nonprobability design, we did not seek to make state-level estimates or comparisons across states. Despite the potential limits to generalizability, high-quality online panel vendors can provide researchers with quick and cost-efficient access to survey respondents that resemble the general population [45] and this was especially valuable in the present study where the policy environment is rapidly changing, and there is a need for measurement to inform ongoing research and policy discussions.

Conclusion

Although direct marketing of cannabis on social media remains illegal, youth are exposed to cannabis products and content via promotional pages, and such exposure is associated with cannabis use. Current policies to help prevent exposure to cannabis marketing online are not effective. While larger, longitudinal studies about exposure to cannabis marketing on social media and onset of adolescent cannabis use are needed, states should consider adopting the most restrictive cannabis marketing policies feasible, combined with an accountability and enforcement infrastructure that will help protect the current generation of adolescents.

Funding Sources

This project was supported by grant number R01DA041641 (PI: Moreno). Dr. Trangenstein was also supported by award numbers T32AA007240, Graduate Research Training in Alcohol Problems: Alcohol-related Disparities, and P50AA005595, Epidemiology of Alcohol Problems: Alcohol-Related Disparities from the National Institute on Alcohol Abuse and Alcoholism.

Supplementary Data

Supplementary data related to this article can be found at http://doi.org/10.1016/j.jadohealth.2019.08.024.

References

[1] Johnston L, Miech R, O'Malley PM, et al. Monitoring the Future national survey results on drug use 1975-2018: Overview, key findings on adolescent drug use. Ann Arbor: Institute for Social Research, University of Michigan; 2019.
[2] Winters KC, Lee CY. Likelihood of developing an alcohol and cannabis use disorder during youth: Association with recent use and age. Drug Alcohol Depend 2008;92:239–47.
[3] Silins E, Horwood LJ, Patton GC, et al. Young adult sequelae of adolescent cannabis use: An integrative analysis. Lancet Psychiatry 2014;1:286–93.
[4] Hasin DS. US Epidemiology of cannabis use and associated problems. Neuropsychopharmacology 2018;43:195–212.
[5] Macleod J, Oakes R, Copello A, et al. Psychological and social sequelae of cannabis and other illicit drug use by young people: A systematic review of longitudinal, general population studies. Lancet 2004;363:1579–88.
[6] Rogeberg O, Elvik R. The effects of cannabis intoxication on motor vehicle collision revisited and revised. Addiction 2016;111:1348–59.
[7] National Conference of State Legislatures. State Medical Marijuana Laws. Available at: http://www.ncsl.org/research/health/state-medical-marijuana-laws.aspx. Accessed July 11, 2019.
[8] Leon K, Weitzer R. Legalizing recreational marijuana: Comparing ballot outcomes in four states. J Qual Crim Justice Criminol 2014;2.
[9] Barry RA, Glantz SA. Marijuana regulatory frameworks in four US states: An analysis against a public health standard. Am J Public Health 2018;108:914–23.
[10] Substance Abuse and Mental Health Services Administration (SAMHSA). Report to congress on the prevention and reduction of underage drinking. Rockville, MD: U.S. Department of Health and Human Services (HHS); 2018.
[11] Kalant H. A critique of cannabis legalization proposals in Canada. Int J Drug Policy 2016;34:5–10.
[12] Associated Press. Legal marijuana injustry had banner year in 2018 with $10B worth of investments. Available at: https://www.nbcnews.com/news/us-news/legal-marijuana-industry-had-banner-year-2018-10b-worth-investments-n952256. Accessed February 10, 2018.
[13] Pan American Health Organization. Technical note: Background on alcohol marketing regulation and monitoring for the protection of public health. Available at: http://iris.paho.org/xmlui/handle/123456789/3397. Accessed February 10, 2019.
[14] Pickel J. You can promote a cannabis brand on social media but not easily. Available at: https://www.greenentrepreneur.com/article/320031. Accessed May 31, 2019.
[15] Moreno MA, Gower AD, Jenkins MC, et al. Marijuana promotions on social media: Adolescents' views on prevention strategies. Subst Abuse Treat Prev Policy 2018;13:23.
[16] Jernigan D, Noel J, Landon J, et al. Alcohol marketing and youth alcohol consumption: A systematic review of longitudinal studies published since 2008. Addiction 2017;112:7–20.
[17] Lovato C, Watts A, Stead LF. Impact of tobacco advertising and promotion on increasing adolescent smoking behaviours. Cochrane Database Syst Rev 2011. CD003439.
[18] Anderson M, Teens Jiang J. Social media, and technology 2018. Washington, DC: Pew Research Center; 2018.
[19] Dai H. Exposure to advertisements and marijuana use among US adolescents. Prev Chronic Dis 2017;14:E124.
[20] D'Amico EJ, Rodriguez A, Tucker JS, et al. Planting the seed for marijuana use: Changes in exposure to medical marijuana advertising and subsequent adolescent marijuana use, cognitions, and consequences over seven years. Drug Alcohol Depend 2018;188:385–91.
[21] Krauss MJ, Sowles SJ, Sehi A, et al. Marijuana advertising exposure among current marijuana users in the U.S. Drug Alcohol Depend 2017;174:192–200.
[22] Bierut T, Krauss MJ, Sowles SJ, et al. Exploring marijuana advertising on weedmaps, a popular online directory. Prev Sci 2017;18:183–92.
[23] Fiala SC, Dilley JA, Firth CL, et al. Exposure to marijuana marketing after legalization of retail sales: Oregonians' experiences, 2015–2016. Am J Public Health 2017;108:120–7.
[24] Conner M, McMillan B. Interaction effects in the theory of planned behaviour: Studying cannabis use. Br J Soc Psychol 1999;38:195–222.
[25] Brown A, Moodie C. The influence of tobacco marketing on adolescent smoking intentions via normative beliefs. Health Educ Res 2009;24:721–33.
[26] McClure AC, Stoolmiller M, Tanski SE, et al. Alcohol marketing receptivity, marketing-specific cognitions, and underage binge drinking. Alcohol Clin Exp Res 2013;37:E404–413.
[27] Real K, Rimal RN. Friends talk to friends about drinking: Exploring the role of peer communication in the theory of normative social behavior. Health Commun 2007;22:169–80.
[28] Jernigan DH, Ostroff J, Ross C. Alcohol advertising and youth: A measured approach. J Public Health Policy 2005;26:312–25.
[29] Shurtleff M, Gansler D, Horne T, et al. RE: Alcohol reports, paperwork comment; project no. P114503. A communication from the Chief Legal Officers of the following states: Arizona, Connecticut, Delaware, Guam, Hawaii, Idaho, Illinois, Iowa, Maryland, Massachusetts, Mississippi, Nevada, New Hampshire, New Mexico, New York, Oklahoma, Oregon, Rhode Island, South Carolina, Tennessee, Utah, Vermont, Washington, Wyoming. Available at: https://www.ftc.gov/sites/default/files/documents/public_comments/alcohol-reports-project-no.p114503-00071%C2%A0/00071-58515.pdf. Accessed July 31, 2019.
[30] Noel JK, Babor TF, Robaina K. Industry self-regulation of alcohol marketing: A systematic review of content and exposure research. Addiction 2017;112:28–50.
[31] Mosher JF. Alcohol industry voluntary regulation of its advertising practices: A status report. Center for the Study of Law and Enforcement Policy: Pacific Insitute for Research and Evaluation; 2006.

[32] Miech R, Johnston L, O'Malley P, et al. Monitoring the Future national survey results on drug use, 1975-2014: Volume I, secondary school students. Ann Arbor, MI: Institute for Social Research; 2018.
[33] Papinczak ZE, Connor JP, Harnett P, et al. A biosocial cognitive model of cannabis use in emerging adulthood. Addict Behav 2018;76:229–35.
[34] Heen MSJ, Lieberman JD, Miethe TD. A comparison of different online sampling approaches for generating national samples, vol. 1. Las Vegas, NV: UNLV Center for Crime and Justice Policy; 2014.
[35] Wang TW, Gentzke A, Sharapova S, et al. Tobacco product use among middle and high school students - United States, 2011-2017. MMWR Morb Mortal Wkly Rep 2018;67:629–33.
[36] Centers for Disease Control and Prevention. National Youth Tobacco Survey - 2017 Questionnaire. Atlanta, GA: Centers for Disease Control and Prevention; 2018.
[37] Biener L, Siegel M. Tobacco marketing and adolescent smoking: More support for a causal inference. Am J Public Health 2000;90:407–11.
[38] Smith A, Anderson M. Social media use in 2018. Washington, DC: Pew Research Center; 2018.
[39] Washington State Liquor and Cannabis Board. Frequently asked questions about marijuana advertising. Available at: https://lcb.wa.gov/mj2015/faq_i502_advertising#traditionaladv. Accessed January 10, 2019.
[40] Center for Addiction and Mental Health. Cannabis policy framework. Toronto, ON: University of Toronto; 2014.
[41] Henriksen L. Comprehensive tobacco marketing restrictions: Promotion, packaging, price and place. Tob Control 2012;21:147–53.
[42] Tobacco Control Legal Consortium. Sunshine Laws: Requiring reporting of tobacco industry price discounting and promotional allowance payments to retailers and wholesalers. Available at: https://www.publichealthlawcenter.org/sites/default/files/resources/tclc-guide-sunshinelaws-tobaccocontrol-2012_0.pdf. Accessed August 1, 2019.
[43] Sanchez L, Sanchez S, Goldberg A, et al. Tobacco and alcohol advertisements in magazines: Are young readers being targeted? JAMA 2000;283:2106–7.
[44] D'Amico EJ, Miles JN, Tucker JS. Gateway to curiosity: Medical marijuana ads and intention and use during middle school. Psychol Addict Behav 2015;29:613–9.
[45] Craig BM, Hays RD, Pickard AS, et al. Comparison of US panel vendors for online surveys. J Med Internet Res 2013;15:e260.