



Active cannabis marketing and adolescent past-year cannabis use

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ABSTRACT

Methods: Data are from an online survey of 482 adolescents (aged 15–19 years) living in states with legalized retail cannabis. Youth were asked about their engagement with cannabis promotions, including whether they liked/followed cannabis businesses on social media (Facebook, Twitter, and Instagram), had a favorite cannabis brand, or could see themselves owning/wearing a cannabis-branded product. Youth also self-reported cannabis use in the past year. We used logistic regression with a Bonferroni correction to compare the odds of cannabis use among youth with different levels of engagement with cannabis promotions and brands after controlling for demographics.

Results: After adjusting for several possible confounders, youth who liked or followed a cannabis business on at least one social media platform had 5 times higher odds of past-year cannabis use ($aOR = 5.00$, 95% CI : 2.47, 10.09, $p < 0.001$). Youth who thought it was likely that they would own or wear cannabis-branded merchandise ($aOR = 6.93$, 95% CI : 4.45, 10.78, $p < 0.001$) or who had a favorite cannabis brand ($aOR = 7.98$, 95% CI : 4.90, 13.00, $p < 0.001$) had nearly 8 times greater odds of past-year cannabis use.

Conclusion: Youth who engage with cannabis promotions and brands had higher odds of past-year cannabis use. Jurisdictions with retail cannabis may want to consider restrictions to limit youth engagement with cannabis promotions.

1. Introduction

Over the past 20 years, momentum to repeal cannabis prohibition has swept across much of the United States (US). Starting with the establishment of laws for medical cannabis in California in 1996, states have embarked on a series of natural experiments in regulatory regimes governing the manufacture, sale, and use of medical and retail cannabis in their jurisdictions. As of 2018, more than one in five (21.5%) Americans lives in a state with legalized retail cannabis (US Census Bureau, 2018). Despite this ballooning access to an \$8.5 billion legal cannabis market in 2017 (The Arcview Group, 2018), cannabis remains a Schedule I drug under the federal Controlled Substances Act. This prevents researchers from using federal funds to investigate cannabis and leaves states to draw on an incomplete literature on the public health consequences of cannabis use as they draft new policies.

As evidenced by the American Academy of Pediatrics' (American College of Pediatricians, 2017) statement against cannabis use among youth, neuropsychiatric risks to adolescents are one of the few areas of consensus in the cannabis literature (Meier et al., 2012; Moore et al., 2007). This suggests that regulatory approaches should aim to delay youth initiation of cannabis use. Across the US in 2017, 15.3% of youth aged 12–17 years had tried cannabis in their lives, and 12.4% had used cannabis in the past year (Substance Abuse and Mental Health Services Administration, 2018). These youth who initiate cannabis use by age 18 have 3.9–7.2 times greater odds of cannabis use disorders (i.e., daily or problematic use that does not result in addiction) (Winters and Lee, 2008), and youth who start using cannabis by age 16 have higher odds of cannabis dependence (i.e., cannabis use that produces withdrawal) (Swift et al., 2008). Further, early onset chronic cannabis use (defined as chronic use by age 15) is associated with decreased cortical

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functioning (Fontes et al., 2011) and schizophrenia (Commission, 2012).

It is not clear whether recent changes in regulatory approaches governing the use and retail sale of medical and retail cannabis have increased youth uptake (Cerdá et al., 2017; Dilley et al., 2018; Lynne-Landsman et al., 2013). Cannabis marketing is one aspect of the new industry that warrants attention, because there is reason to believe that youth with greater exposure to cannabis marketing may have higher cannabis use and related harms. In particular, data from alcohol and tobacco marketing provide compelling evidence that marketing can affect youth drug use. Tobacco marketing may increase the appeal of smoking (Arnett and Terhanian, 1998; Turco, 1997) and recruit new smokers (Henriksen et al., 2002; Pechmann and Knight, 2002; Unger et al., 1995). Two systematic reviews of longitudinal studies on alcohol marketing have found that young people with greater exposure to alcohol marketing appear more likely subsequently to initiate alcohol use (if they did not drink previously) and engage in binge and hazardous drinking (if they did drink previously) (P. Anderson et al., 2009; D. Jernigan et al., 2016).

Like alcohol and tobacco, cannabis is becoming a legal intoxicant for adults. However, cannabis is unique in many ways. Youth may assume that cannabis is safe and/or has potential health benefits because cannabis use is legalized for medicinal purposes in some states, and adolescents are quickly becoming more likely to perceive no or fewer risks from cannabis use (Johnston et al., 2018; Sarvet et al., 2018). While the alcohol and tobacco industries crafted their original marketing campaigns decades ago using traditional media (e.g., print, billboards, radio), cannabis businesses have their origins in the digital age and consequently, they rely largely on social media to sell their products. This shift could have profound implications for youth, 45% of whom report being online “almost constantly” (M. Anderson and Jiang, 2018). In addition, new potential for interactive engagement and integration into peer networks may increase youth vulnerability to digital marketing (D. H. Jernigan, 2012; Montgomery et al., 2012). The combination of high youth social media use and prevalence of online cannabis marketing suggests a need to understand whom these promotions reach and how they affect outcomes such as youth cannabis use.

Like many dimensions of the legal cannabis market, the reach and consequences of cannabis promotions among adolescents in online media is largely unknown, but the emerging evidence gives cause for concern. Cannabis promotions may reach large segments of the US, and youth and racial/ethnic minorities may have disproportionately higher exposure to these promotions (Park and Holody, 2018). For example, one study examined cannabis advertisement (ad) and promotion exposure among adult cannabis users (aged 18–35 years) from states with legal and illegal retail cannabis use (Krauss et al., 2017a, 2017b). It found that Facebook (47%) was the most common platform for passive cannabis ad/promotion exposure, followed by print media (30%) and Instagram (27%) (Krauss et al., 2017a, 2017b). Another study examined youth exposure to medicinal cannabis ads and found that greater ad exposure doubled middle schoolers’ odds of current cannabis use and current cannabis use predicted future ad exposure (D’Amico et al., 2015). However, this study was unable to comment directly on social media cannabis promotions (D’Amico et al., 2015). Finally, exposure to positive cannabis content on Twitter was associated with increased odds of current cannabis use among young adults (Cabrera-Nguyen et al., 2016).

McClure et al.’s Marketing Receptivity Model (McClure et al., 2013), which is based on the Theory of Normative Social Behavior (R. Rimal and Real, 2005), provides a framework for understanding how youth exposure to and interaction with marketing. As described by Rimal and colleagues, the Theory of Normative Social Behavior proposes that *injunctive norms* (i.e., notions of others’ expectations for behavior), *outcome expectations* (i.e., beliefs about consequences of a behavior), and *group identity* (i.e., perception of belonging to a group) shape behavior (R. Rimal and Real, 2005). Drawing on Pierce’s concept of *marketing*

receptivity (i.e., the attitudinal response to marketing) (Pierce et al., 1998), the Marketing Receptivity Model outlines a process in which youth progressively interact with marketing (McClure et al., 2013). The first stage involves passive marketing exposure in which youth are exposed to marketing, the content of which begins to shape injunctive norms and outcome expectancies (McClure et al., 2013). As youth gain awareness of the marketing, they may begin to remember/recognize it (McClure et al., 2013). The final stage comprises active marketing exposure, in which a subset of youth interacts with the marketing through liking, commenting, or following business pages, communicating their preferences to friends, and generating their own marketing (McClure et al., 2013).

This manuscript is a first step in exploring the association between youth engagement with cannabis marketing and use. We consider marketing materials to include both cannabis advertising (i.e., a public notice or communication promoting a good or service) and promotions (i.e., cannabis business pages and communications that occur in social media). Based on the Marketing Receptivity Model, we hypothesize that youth who interact with cannabis ads and/or promotions (i.e., like or follow cannabis social media pages) or engage in actions/beliefs associated with positive receptivity (i.e., have a favorite cannabis brand, or report owning/wearing cannabis branded merchandise) will have higher odds of cannabis use.

2. Methods

2.1. Data source

This survey included 501 adolescents recruited by Qualtrics in roughly equal numbers of young adolescents (ages 15–17 years old) and older adolescents (18+ years old), which was a criterion for how the adolescents were recruited. Respondents completed the survey online using the Qualtrics portal. Qualtrics recruited respondents in February 2018 using the following criteria: 1) Resident of Alaska, California, Colorado, Nevada, Maine, or Washington, 2) Adolescent aged 15–19 years old, and 3) English speaker.

2.2. Procedures

Qualtrics recruits panel members through proprietary partners. Most members are recruited via social media advertisements or messages in mobile applications (e.g. games). To reach youth aged 15–17 years old, Qualtrics approached adult members of their internet panel who reported that they were parents of adolescents. Qualtrics obtained youth aged 18–19 years old directly from their panel. Adolescent’s parents provided informed consent (if the adolescent was under 18 years old) and the adolescents provided informed assent (if they were under 18) or consent (if they were 18–19 years old) before completing the online survey in a private location. Roughly 46% of individuals who were invited to participate in the survey agreed. Adolescents received Qualtrics points, which can be used to obtain gift cards, in-app purchases, or airline miles, as an incentive to thank them for their time. Qualtrics’ recruitment procedures include a background check in order to avoid individuals participating in any survey more than one time. This survey was approved by the University of Wisconsin Madison’s Institutional Review Board.

2.3. Measures

The survey included demographics, social media use (adapted from the Pew Internet and American life project (Madden et al., 2010)), cannabis ad exposure in traditional and social media platforms (adapted from the National Youth Tobacco Survey (Centers for Disease Control and Prevention, 2013)), and cannabis use (adapted from the marijuana use behavior questions in (R. N. Rimal and Mollen, 2013)). We selected covariates using best subset selection. Covariates included

Table 1
Demographics, cannabis social media engagement, and cannabis use characteristics of survey sample (n = 482).

Characteristic	Total # (%)	Engagement with cannabis social media ^a			Past year cannabis use		
		No (n = 442) # (%)	Yes (n = 40) # (%)	p-value	No (n = 336) # (%)	Yes (n = 146) # (%)	p-value
Age				0.24			0.06
15-17 years	236 (49.0%)	16 (6.8%)	220 (93.2%)		174 (73.7%)	62 (26.3%)	
18-19 years	246 (51.0%)	24 (9.8%)	222 (90.2%)		162 (65.9%)	84 (34.2%)	
Gender				0.86			0.79
Male	127 (26.4%)	29 (8.6%)	307 (91.4%)		234 (69.6%)	102 (30.4%)	
Female	336 (69.7%)	10 (7.9%)	117 (92.1%)		90 (70.9%)	37 (29.1%)	
Other ^b	19 (3.9%)	1 (5.3%)	18 (94.7%)		12 (63.7%)	7 (36.8%)	
Race/Ethnicity				0.39			0.59
white	194 (40.3%)	12 (6.2%)	182 (93.8%)		132 (68.0%)	62 (32.0%)	
African American	35 (7.3%)	5 (14.3%)	30 (85.7%)		24 (68.6%)	11 (31.4%)	
Hispanic/Latino	166 (34.4%)	15 (9.0%)	151 (91.0%)		114 (68.7%)	52 (31.3%)	
Other	87 (18.1%)	8 (9.2%)	79 (91.0%)		66 (75.9%)	21 (24.1%)	
Parent education				0.30			< 0.01
High school or some college	365 (75.7%)	33 (9.0%)	332 (91.0%)		241 (66.0%)	124 (34.0%)	
Bachelor's degree or higher	117 (24.3%)	7 (6.0%)	110 (94.0%)		95 (81.2%)	22 (18.8%)	

^a Engagement with cannabis social media business pages defined as liking, following, and/or commenting on a cannabis business page on Facebook, Twitter, and/or Instagram.

^b Other gender includes non-binary gender, male-to-female transgender, female-to-male transgender, and other.

age, gender, race/ethnicity, and parent education. We considered additional covariates such as residential state and timing of state legalization of retail cannabis, but they were not significant in the past-year analyses, so we dropped them in an effort to build parsimonious models.

Demographics included age, gender, race/ethnicity, and parent education (a proxy for socioeconomic status). Age was categorized as 15–17 years for middle adolescence and 18–19 years for older adolescence. Gender was originally captured as male, female, non-binary gender, female-to-male transgender, male-to-female transgender, and other. We created a three-category gender variable with male, female, and other categories. Race/ethnicity was categorized as white, African American, Hispanic/Latino, or other. Parent education was categorized as a binary variable that indicated whether at least one parent held a bachelor's degree or higher.

Favorite cannabis brand was captured using one question, “What is the name of your favorite cannabis brand?” We recoded this as a binary variable that indicated whether the respondent entered a brand name or not. Our variable for favorite cannabis brand was designed to measure the third stage of the marketing receptivity model, in which youth begin to remember/recognize marketing (McClure et al., 2013).

The likelihood of owning a branded cannabis product was intended to measure the youth's perception of the likelihood that they would reach the final stage of the marketing receptivity model. It was captured using one question, “How likely is it that you would ever use or wear something such as a t-shirt or sunglasses that has a cannabis brand name logo or picture on it?” Response options used a seven-point Likert scale ranging from extremely likely to extremely unlikely. We recoded this item as a binary variable that indicated whether the respondent was likely (including options for slightly, moderately, or extremely likely) to wear or own a branded cannabis product or not (including options for extremely unlikely, moderately unlikely, slightly likely and neither likely nor unlikely).

Cannabis social media engagement was intended to measure the final stage of the marketing receptivity model and it comprised a series of three questions using a common format. These questions asked, “Do you like/follow any cannabis business pages on [MEDIA PLATFORM]? If so, which ones? This question was asked for Facebook, Twitter, and Instagram. We created one binary variable that indicated whether the participant liked or followed any cannabis business pages on Facebook, Twitter, and/or Instagram, and we created three binary variables to identify youth who engaged with cannabis business pages on Facebook,

Twitter, and Instagram separately.

Cannabis use was captured on the survey for three recall periods: lifetime (ever), past 12 months, and past 28 days. We selected past year use as a measure for current use for the primary models, because early initiates may use cannabis less than monthly, and we provide results for past 28-day use in the supplemental online appendix. Past year cannabis use was measured using one question, “Which of the following types of cannabis have you used in the past 12 months?” Response options included cannabis (plant), concentrates/extracts, edibles, other, and “I have not used cannabis in the past 12 months.” We calculated past year cannabis use using one binary variable in which youth who reported using at least one type of cannabis (plant, concentrate/extract, edible, or other) were coded as “yes,” and youth who answered “I have not used cannabis in the past 12 months” were coded as “no.” Past 28-day use was assessed using an analogous set of questions that replaced “12 months” with “28 days.”

2.4. Analyses

Bivariate analyses included chi-squared tests of association and simple logistic regressions. We then conducted a series of multiple logistic regressions that adjusted for demographic covariates. We used a Bonferroni correction for multiple testing. As we had six regression models, p-values less than 0.008 were considered statistically significant.

We conducted a specification link test to determine whether any models were mis-specified. We assessed model fit using Hosmer-Lemeshow Goodness of Fit Test with 10 groups. All models were well-specified and had an acceptable model fit. We also examined variance inflation factors (VIFs) to determine if collinearity was a problem, and all VIFs were 1.05 or less.

3. Results

The analytic sample included the 482 adolescents (aged 15–19 years old) who had complete demographic and cannabis use data (see Table 1). Thirty-eight adolescents were excluded because they were missing race (n = 37) or parent education (n = 1) data.

3.1. Demographics

The sample was roughly evenly divided by youth in mid

adolescence (ages 15–17 years, 49.0%) and older adolescence (ages 18–19 years, 51.0%). About two-thirds (69.7%) of the sample identified as female. Forty percent of the sample was white, 34.4% was Hispanic or Latino, 18.1% reported another race/ethnicity, and 7.3% was African American. The majority of the sample resided in California (56.4%), Washington (18.3%), or Colorado (12.5%). A smaller percentage were from Nevada (8.1%), Maine (3.5%), or Alaska (1.2%).

3.2. Cannabis social media engagement, favorite brands, and branded products

Thirty-nine youth liked or followed at least one cannabis business pages on Facebook, Twitter, and/or Instagram. Of these 39 youth, 56.4% engaged with cannabis business pages on Facebook, 28.2% on Twitter, and 61.5% on Instagram. Twenty-two percent (22.2%) of respondents reported having a favorite cannabis brand, and 32.6% of respondents reported it was likely that they would wear or own a branded cannabis product.

3.3. Cannabis use

Thirty percent of youth (30.3%) reported using cannabis in the past 12 months, and 26.9% reported using it in the past 28 days. Youth who used cannabis in the past year were more likely to have parents with less than a bachelor's degree (34.0% vs. 18.8%, $\chi^2 = 9.66$, $p < 0.01$), but they did not differ by age (26.3% vs. 34.2%, $\chi^2 = 3.54$, $p = 0.06$), gender (30.4% vs. 29.1% vs. 36.8%, $\chi^2 = 0.47$, $p = 0.79$), or race/ethnicity (32.0% vs. 31.4% vs. 31.3% vs. 24.1%, $\chi^2 = 1.92$, $p = 0.59$).

3.4. Bivariate associations between cannabis social media engagement and cannabis use

Thirty-four percent of youth (34.4%) reported owning or seeing themselves as likely to own cannabis-branded merchandise (data not shown). These youths were more likely to also report past-year cannabis use than their peers who thought it was unlikely that they would own/wear such merchandise (16.1% vs. 57.2%, $\chi^2 = 87.02$, $p < 0.001$). Slightly fewer youth (23.2%) reported having a favorite cannabis brand. Past year (66.1% vs. 19.5%, $\chi^2 = 88.46$, $p < 0.001$, data not shown), and past 28-day self-reported cannabis use (62.2% vs. 16.3%, $\chi^2 = 91.13$, $p < 0.001$) was more prevalent among youth who reported having a favorite cannabis brand than youth who did not.

Across the three measures of active marketing, the fewest youths (8.3%) reported engaging with cannabis business pages on social media. These youths did not differ by age, gender, race/ethnicity, or parent educational attainment. Youth who reported engaging with cannabis social media business pages were more likely to report using cannabis in the past year (27.2% vs. 65.0%, $\chi^2 = 24.89$, $p < 0.001$, data not shown).

3.5. Regression results for association between cannabis social media engagement and cannabis use

Table 2 summarizes the results of the multiple logistic regression for active cannabis marketing and past year cannabis use. After adjusting for age, gender, race/ethnicity, and parent education, youth who engaged with cannabis business pages on social media had five times higher odds of past year cannabis use as compared to those who did not engage with these pages ($aOR = 5.00$, 95% CI: 2.47, 10.09, $p < 0.001$). Similar relationships emerged for Facebook ($aOR = 6.22$, 95% CI: 2.33, 16.56, $p < 0.001$) and Instagram ($aOR = 4.26$, 95% CI: 1.77, 10.27, $p = 0.001$). Although youth who engaged with cannabis Twitter handles tended to have higher odds of past year cannabis use, this adjusted odds ratio did not reach statistical significance after the Bonferroni correction ($aOR = 6.35$, 95% CI: 1.60, 25.21, $p = 0.001$). In the past 28 day models, youth who engaged with cannabis business

pages had three times the odds of past-month cannabis use ($aOR = 3.38$, 95% CI: 1.41, 8.13, $p = 0.007$), but the platform-specific associations were not significant.

Table 3 shows the results of the multiple logistic regression for the association between cannabis brand engagement (i.e., having a favorite cannabis brand or owning/seeing oneself owning cannabis-branded merchandise). Youth who reported a favorite cannabis brand had nearly 8 times the odds of past year cannabis use ($aOR = 7.98$, 95% CI: 4.90, 13.00, $p < 0.001$) and past 28-day use ($aOR = 8.06$, 95% CI: 4.31, 15.06, $p < 0.001$) compared to youth who did not report a favorite brand. Youth who reported either owning or seeing oneself as likely to own cannabis-branded merchandise had roughly 7 times the odds of past year ($aOR = 6.93$, 95% CI: 4.45, 10.78, $p < 0.001$) and 12 times the odds of past 28-day cannabis use ($aOR = 12.04$, 95% CI: 6.53, 22.20, $p < 0.001$) as compared to youth who did not report owning or seeing oneself as likely to own cannabis-branded merchandise. Ethnicity modified the association between owning branded merchandise and past 28-day cannabis use such that Hispanic/Latino youth who owned such merchandise had three times the odds of past 28-day use ($aOR = 3.11$, 95% CI: 1.51, 6.39, $p = 0.002$).

4. Discussion

This survey is among the first to measure the association between engagement with cannabis promotions among adolescents and cannabis use. This study finds that roughly one-third of youth in states with legalized retail cannabis interact with cannabis marketing. Youth who reported a favorite cannabis brand, owned or could see themselves owning cannabis-branded merchandise, or engaged with (by liking, following, or commenting on) cannabis business pages on social media had higher odds of past-year cannabis use. This finding is consistent with previous research that found that active engagement with cannabis promotions on Twitter was associated with greater odds of cannabis use among young adults (Cabrera-Nguyen et al., 2016). It also extends our previous finding that 90.3% of youth in this sample said they had been exposed to at least one type of cannabis ad or promotion (Trangenstein et al., 2019). This finding is also consistent with the much larger body of literature on alcohol advertising and youth. In particular, two systematic reviews of longitudinal studies from 1990 to 2016 show a definitive relationship between alcohol advertising exposure and both initiation of alcohol consumption and increased consumption (if already initiated), including binge drinking, in underage youth (P. Anderson et al., 2009; D. Jernigan et al., 2016).

A key strength of this analysis is that it is grounded in the Marketing Receptivity Model (McClure et al., 2013), which provides a theoretical rationale that explains one way that cannabis promotions could be associated with cannabis use. As hypothesized by the Marketing Receptivity Model, there appeared to be progressive levels of cannabis promotion engagement. Roughly one in three youth had a favorite cannabis brand (the fourth step of the Marketing Receptivity Model, likes marketing) and slightly fewer youth (about one in four) reported owning or seeing themselves as owning cannabis branded merchandise (the fifth step, interactive marketing participation). The most selective measure of receptivity appeared to be engaging with cannabis business pages on social media, which roughly one in twelve youth reported. Because of the peer network dimensions of social media, this could align with the sixth step, “communicates preferences to friends.”

A growing literature uses Qualtrics to obtain youth samples for surveys on media (Bushman et al., 2012; Len-Rios et al., 2016). However, we obtained our sample using non-probability methods and an internet panel, which means it is vulnerable to selection biases such as self-referral and non-response biases. Qualtrics also obtained parental permission before approaching youth who were 15–17 years old. This added an opportunity for respondents to decline participation, but it is a standard practice from a research ethics perspective.

Previous studies have shown that demographics of samples

Table 2

Multiple logistic regression for association between platform-specific cannabis social media engagement and past year cannabis use.

Characteristic	Any engagement			Facebook			Twitter			Instagram		
	aOR	95% CI	P-Val	aOR	95% CI	P-Val	aOR	95% CI	P-Val	aOR	95% CI	P-Val
Engagement ^a												
None	(ref)											
Any platform	5.00	2.47, 10.09	< 0.001									
Facebook												
No				(ref)								
Yes				6.22	2.33, 16.56	< 0.001						
Twitter												
No							(ref)					
Yes							6.35	1.60, 25.21	0.009			
Instagram												
No										(ref)		
Yes										4.26	1.77, 10.27	0.001
Age												
15-17 years	(ref)			(ref)			(ref)			(ref)		
18-19 years	1.34	0.89, 2.01	0.17	1.30	0.86, 1.95	0.21	1.34	0.89, 2.00	0.21	1.41	0.94, 2.11	0.10
Gender												
Male	0.91	0.57, 1.46	0.70	0.89	0.56, 1.42	0.63	0.92	0.58, 1.46	0.72	0.94	0.59, 1.50	0.80
Female	(ref)			(ref)			(ref)			(ref)		
Other ^b	1.38	0.50, 3.79	0.53	1.30	0.47, 3.58	0.61	1.37	0.51, 3.71	0.53	1.40	0.52, 3.78	0.51
Race/Ethnicity												
white	(ref)			(ref)			(ref)			(ref)		
African American	0.80	0.35, 1.80	0.58	0.84	0.37, 1.88	0.67	0.79	0.35, 1.78	0.57	0.85	0.38, 1.89	0.69
Hispanic/Latino	0.87	0.54, 1.39	0.55	0.90	0.56, 1.43	0.65	0.87	0.55, 1.39	0.56	0.86	0.54, 1.38	0.53
Other	0.68	0.37, 1.24	0.20	0.73	0.40, 1.32	0.30	0.72	0.40, 1.31	0.28	0.67	0.37, 1.22	0.19
Parent education												
High school/some college	(ref)			(ref)			(ref)			(ref)		
Bachelor's degree or higher	0.47	0.27, 0.80	0.005	0.47	0.28, 0.80	0.005	0.45	0.27, 0.77	0.003	0.48	0.28, 0.81	0.006

Bold indicates statistically significant after Bonferroni correction ($p < 0.008$).

aOR adjusted odds ratio; CI confidence interval; p-val p-value.

^a Engagement with cannabis social media business pages defined as liking, following, and/or commenting on a cannabis business page on Facebook, Twitter, and/or Instagram.^b Other gender includes non-binary gender, male-to-female transgender, female-to-male transgender, and other.**Table 3**

Associations between cannabis brand engagement on social media and past year cannabis use.

Characteristic	Favorite cannabis brand			Own cannabis branded merchandise		
	aOR	95% CI	P-Val	aOR	95% CI	P-Val
Brand engagement						
No	(ref)			(ref)		
Yes	7.98	4.90, 13.00	< 0.001	6.93	4.45, 10.78	< 0.001
Age						
15-17 years	(ref)			(ref)		
18-19 years	1.00	0.64, 1.56	0.99	1.14	0.73, 1.77	0.57
Gender						
Male	0.84	0.51, 1.39	0.49	0.80	0.49, 1.33	0.39
Female	(ref)			(ref)		
Other ^a	1.50	0.51, 4.44	0.46	1.11	0.37, 3.33	0.85
Race/Ethnicity						
white	(ref)			(ref)		
African American	0.60	0.25, 1.46	0.26	0.77	0.32, 1.84	0.56
Hispanic/Latino	0.87	0.52, 1.44	0.59	0.75	0.45, 1.24	0.26
Other	0.72	0.38, 1.37	0.32	0.66	0.35, 1.26	0.21
Parent education						
High school/some college	(ref)			(ref)		
Bachelor's degree or higher	0.53	0.30, 0.94	0.03	0.48	0.27, 0.85	0.01

Bold indicates statistically significant after Bonferroni correction ($p < 0.008$).

aOR adjusted odds ratio; CI confidence interval; p-val p-value.

^a Other gender includes non-binary gender, male-to-female transgender, female-to-male transgender, and other.

recruited by Qualtrics can be within 10% of the general US population (Heen et al., 2014). To assess the representativeness of our sample, we compared the composition of study participants to the general US population. We had a larger proportion of females and Hispanic/Latinos and a smaller proportion of whites. However, the representativeness of the exposure-outcome association is perhaps of higher importance than

demographics. Our lifetime cannabis use prevalence (36.0%) was very similar to the 2017 Youth Risk Behavior Survey (YRBS) high school sample (35.6%) and 2018 Monitoring the Future 10th (32.6%) and 12th grade (43.6%) samples (roughly the middle 60% of our sample were in the 10th to 12th grade) (Johnston et al., 2019; Kann et al., 2018). Our past-year cannabis use prevalence (30.3%) fell between the prevalence

rates reported in the MTF 10th (27.5%) and 12th grade (35.9%) samples (Johnston et al., 2019). Finally, our past 28-day consumption prevalence rate (26.1%) was slightly higher than the YRBS high school (19.8%) and MTF 10th grade (16.7%) samples but similar to 2018 MTF 12th grade (22.2%) sample (Johnston et al., 2019; Kann et al., 2018). All of our estimates were within 10 percentage points of the comparison data, and we also note that these comparisons use national samples, so they may be conservative.

Our data were also collected via self-administered surveys, which means that they may be prone to social desirability bias, whereby youth may underreport sensitive behaviors (e.g., cannabis use). Our internet panel design may have contributed to this in countervailing ways. Qualtrics requires youth information to administer and maintain their online panels, which prevents anonymous data collection. Underreporting tends to be lower in anonymous designs (Gruca et al., 2007), but internet-based administration can encourage accurate reporting for sensitive items (Brener et al., 2006; Eaton et al., 2010; Lygidakis et al., 2010). Self-reported data are also prone to recall bias, where youth may have forgotten advertising exposures. Similarly, it is also possible that youth may have conflated user-generated posts and formal promotions, as previous research found that a small segment of YouTube videos that featured employees of a dispensary or advocacy group were labeled as promotions (Krauss et al., 2017a,b).

This study was designed to provide a first look on emergent trends. Thus, it did not include all potential media platforms through which youth could be exposed to cannabis promotions, and it is possible that more youth engaged in other active forms of active cannabis marketing such as going to a cannabis company website that our survey did not cover. Youth social media use patterns are rapidly evolving, and platforms that we did not assess using a structured format (e.g., Snapchat, YouTube) may also expose youth to cannabis promotions with the potential for interaction. Our surveys also may have omitted some covariates of interest such as more detailed socioeconomic status data and alcohol use.

In addition, our analysis was cross-sectional, and causality cannot be assumed. In particular, the Reinforcing Spirals Model hypothesizes a bidirectional model in which cannabis users seek out cannabis promotions online and exposure to cannabis promotions increases likelihood of cannabis initiation (Slater, 2007). Future research should replicate these findings with larger, more representative samples and possibly considering longitudinal designs.

Despite these limitations, this study provides a timely investigation into associations between engagement with cannabis promotions and cannabis use among youth. As of early 2019, states are at varying levels of establishing retail cannabis markets. In states with more developed markets, information about cannabis is increasingly permeating the social fabric, and new media likely play a large role in this change, particularly among youth (Park and Holody, 2018). In these easily accessed online spaces, there is both a prominent and popular presence of pro-cannabis users and little evidence of a public health perspective. Large segments of adolescents are exposed to and beginning to interact with this marketing in ways that may increase early cannabis initiation and related harms.

These findings underscore the need to further investigate the effects of cannabis promotions on adolescents and to identify regulatory strategies to reduce and prevent this exposure. States may look to comprehensive strategies adopted to combat youth exposure to tobacco advertising in the US or to on-line alcohol marketing in Finland (Montonen and Tuominen, 2017). In 2015, Finland implemented comprehensive restrictions to prevent two forms of alcohol brand engagement: gamification and social influence advertising. Specifically, these new laws prohibited online marketing from containing text or visuals generated by consumers, content intended to be shared by consumers, and interactive games, contests, quizzes, surveys, lotteries, etc. These restrictions focused on gamification and social influence advertising (Montonen and Tuominen, 2017). Two key lessons learned

from the Finnish regulations are that it is often better to specify content that is allowed rather than that which is not, and that cross-national marketing requires cross-national solutions (Montonen and Tuominen, 2017). We encourage future research on social media marketing restrictions, as this is an area of alcohol policy where most countries lag behind (World Health Organization, 2018), thus providing few templates for cannabis.

Considering that any cannabis use by adolescents remains illicit, the widespread availability of cannabis marketing materials is concerning. This study extends prior research by documenting that one-third of youth interact with cannabis marketing and that this brand engagement is associated with recent cannabis use. As the legal cannabis market continues to expand, efforts to evaluate the consequences of specific cannabis marketing regulations may be critical to protecting adolescents from cannabis-related harms.

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Contributors

MM, MJ, and JW conceptualized the analysis. PT analyzed the data and drafted the manuscript with input from all co-authors. All co-authors read the manuscript and provided substantive comments. All authors read and approved the final manuscript.

Declaration of Competing Interest

No conflict declared.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.drugalcdep.2019.107548>.

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