Exposure to cannabis marketing in the United States and differences by cannabis laws: Findings from the International Cannabis Policy Study

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ARTICLE INFO

ABSTRACT

Background: A growing number of US states have legalized adult "recreational" cannabis; however, there is little evidence on the impact of cannabis policies on cannabis marketing exposure to date. The current study examined marketing exposure in the US, including differences between states where cannabis is illegal ('illegal' states), legal for medical use ('medical'), and legal for recreational use ('recreational').
Methods: Data are from the US component of the International Cannabis Policy Study: national repeat cross-sectional data from surveys conducted with 187,573 respondents aged 16–65 over 6 annual survey waves (2018–2023). Adjusted mixed effects logistic regression (GLIMMIX) models examined differences in self-reported exposure to cannabis marketing ('noticing') by state-level cannabis laws.
Results: Self-reported exposure to cannabis marketing differed across policy changes. Noticing cannabis marketing was lowest in illegal states and increased in the first 12-months following medical legalization (35.4 % vs. 39.2 %: AOR=1.16; 95 % CI=1.01–1.33; p = 0.034). Noticing marketing was highest in 'recreational' states, with increases in the first 12-months following legalization (50.0 % vs. 41.1 %: AOR=1.41; 95 % CI=1.34–1.48; p < .001), and additional increases 1–3 years (56.2 %: AOR=1.20; 95 % CI=1.14–1.25; p < .001) and 4 or more years following legalization (63.9 %: AOR=1.21; 95 % CI=1.16–1.27; p < .001). Noticing was highest among people who consume cannabis and younger ages.
Conclusions: Self-reported exposure to cannabis marketing increases following medical and recreational legalization and is disproportionately noticed by underaged people. Cannabis regulations in 'legal' markets should account for marketing, which has been shown to promote cannabis use.

1. Introduction

A growing number of US states have legalized medical and adult use (or 'recreational') cannabis (National Conference of State Legislatures NCSL, 2024). Compared to legal cannabis markets in other jurisdictions, such as Canada, Uruguay, and Germany, recreational markets in US states feature a higher level of commercialization, including fewer restrictions on cannabis marketing (Barry and Glantz, 2018; National Academies of Sciences, Engineering, and Medicine NASEM, 2017). One of the primary functions of advertisements and promotions is to convey positive messages and brand imagery, which can minimize perceptions of risk and enhance social acceptability and peer approval—all of which are critically important risk factors for youth initiation of tobacco,

e-cigarettes, and alcohol (Anderson et al., 2009; National Center for Chronic Disease Prevention and Health Promotion (US) Office on Smoking and Health, 2012; Wang et al., 2022).

To date, there is relatively little research on the effects of cannabis marketing; however, early evidence demonstrates similar associations with patterns of use and susceptibility as the tobacco and alcohol literature (Chaffee et al., 2024; Noël et al., 2024; Rup et al., 2020; Trangenstein et al., 2021; Whitehill et al., 2020). Exposure to cannabis advertising among adolescents and young adults has been associated with increased cannabis use, lower perceived harm, and earlier initiation of cannabis use (D'Amico et al., 2015; Firth et al., 2022; Whitehill et al., 2020). The relationship between marketing exposure and substance use is likely bidirectional: exposure to cannabis marketing can

increase susceptibility to use by minimizing perceived risk and enhancing positive social norms; at the same time, people who consume cannabis are also more likely to seek out, and be exposed to cannabis marketing (Cabrera-Nguyen et al., 2016; Rup et al., 2020; Trangenstein et al., 2021; Whitehill et al., 2020).

There is emerging evidence that suggests exposure to cannabis marketing increases substantially following legalization of recreational cannabis; however, exposure in jurisdictions without legal sales may still be prevalent. National surveys conducted in Canada and US data in 2018 found that more than half of respondents in recreational US states reported exposure to cannabis marketing in the past 12 months, compared to only 1 in 3 respondents residing in medical and illegal states (Rup et al., 2020). Similarly, survey data collected from 2014 to 2015 of young adults that have used cannabis in the past month, found 46 % of respondents in illegal jurisdictions reported they saw or heard a cannabis advertisement in the past 30 days, compared to 47 % of respondents in states where only medical cannabis is legal, and 66 % where recreational cannabis was legal (Krauss et al., 2017). Research to date indicates youth and underaged people may also be exposed to cannabis marketing, even in jurisdictions without legal recreational sales (D'Amico et al., 2015). Survey data collected in California from 2010 to 2011—prior to recreational legalization in the state—found nearly one-third of youth in grades 6–8 reported noticing at least one medical cannabis advertisement in the past three months. There is some evidence to suggest noticing cannabis marketing may be highest among young people (Rup et al., 2020). National surveys conducted in Canada and US indicate the youngest age group (16–20 years) was associated with the highest levels of past-12-month exposure to cannabis marketing (Rup et al., 2020). Notably, this age group is under the minimum legal age of 21 in all US states with recreational cannabis markets.

Overall, despite concerns about the promotion of cannabis to young people, the extent to which cannabis legalization increases exposure to cannabis advertisements and promotions remains largely unexplored. There are notable gaps in the existing literature, including a lack of data on exposure to cannabis marketing by age and data on the specific marketing channels or 'sources' through which exposure may be occurring. There is also a need for more robust study designs, including 'pre-post' designs that capture changes before and after legalization, and studies that compare trends between states that have and have not legalized recreational or medical cannabis. The primary objective of this study was to explore longer-term trends in exposure to cannabis marketing in the years before and after medical and recreational cannabis legalization in the US. Additionally, this study sought to examine age-related differences in cannabis marketing exposure, including differences in overall levels of exposure and exposure from specific channels.

2. Methods

2.1. Study design

This study used population-level repeat cross-sectional data from national surveys conducted in the US across 6 annual waves (2018–2023) as part of the International Cannabis Policy Study (ICPS). Data are collected from respondents aged 16–65 via self-completed web-based surveys conducted in August-September 2018, September-October 2019, September-November 2020, September-November 2021, September-October 2022, and September-October 2023. Respondents were recruited through the Nielsen Consumer Insights Global Panel and their partners' panels. Nielsen panels were recruited using a variety of probability and non-probability sampling methods. For the ICPS surveys, Nielsen draws stratified random samples from the online panels, with quotas based on age and state of residence. Upon completion, respondents receive remuneration in accordance with their panel's usual incentive structure. The cooperation rate, calculated based on AAPOR Cooperation Rate #2 as the percentage of respondents who completed the survey of eligible respondents that accessed the survey

link, was 64.2 % in 2018, 62.9 % in 2019, 62.0 % in 2020, 60.8 % in 2021, 60.7 % in 2022, and 61.3 % in 2023. Median survey time was 20 min in 2018, 25 min in 2019, 21 min in 2020, 22 min in 2021, 23.3 min in 2022, and 22.2 min in 2023 (American Association for Public Opinion Research AAPOR, 2023). The study was reviewed by and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE#31330). A full description of the study methods is available in the Technical Reports and methodology paper (Corsetti et al., 2023).

2.2. Measures

Frequency of cannabis use – Frequency of cannabis use was analysed in five categories: 'Never consumed', 'Consumed more than 12 months ago', 'Consumed less than monthly, but in the past 12-months', 'Consumed monthly to weekly', and 'Consumed daily'.

Sociodemographic variables – Sex-at-birth, gender identity, age, race, highest education level, perceived income adequacy, and state of residence was assessed. As shown in Supplemental Table 1, age was classified as 16–20 years, 21–30 years, 31–50 years, and 51–65 years, and race was assessed with US-specific measures drawn from the US census bureau (US Census Bureau, 2024). Income adequacy was assessed as an indicator of socioeconomic status (Corsetti et al., 2023).

Cannabis laws – A time-varying state-level variable was created to capture changes in cannabis laws using publicly accessible information (National Conference of State Legislatures NCSL, 2024, National Conference of State Legislatures NCSL, 2023). State-level laws (i.e. 'legal status') were categorized in 3 groups: 'Illegal' (states without legal access to medical or recreational cannabis), 'medical' (legal access to cannabis only with medical recommendation), and 'recreational' (legal access to persons 21 years of age or older). Note that all 'recreational' states have also legalized 'medical' cannabis programs. During the period of study, 6 states implemented medical cannabis laws and 14 implemented recreational laws, as shown in Supplemental Tables 2–4. Given that retail stores and other commercial activities often require several years to become established following changes in legal status, a 7-level variable for 'policy change status' was also created to incorporate state-level legal status and implementation date at each wave: Illegal, 'Medical legalized in past 12 months', 'Medical legalized for 1–3 years', 'Medical legalized for 4 + years', 'Recreational legalized in past 12 months', 'Recreational legalized for 1–3 years', and 'Recreational legalized for 4 + years'.

Exposure to cannabis marketing – Self-reported exposure to cannabis marketing was measured with the question: "In the past 12 months, have you noticed marijuana being advertised or promoted in any of the following places?". Respondents could select each of 11 specific channels described in Section 3.3.1; 'Other' (with the option to type a specification); 'I have not noticed marijuana being advertised or promoted'; 'Don't know'; or 'Refuse to answer'. Responses were recoded into a dichotomous response variable, where 0 =no advertisements noticed and 1 =at least one advertisement noticed. An index variable ('Noticing *Index*') was also created in which the total number of channels selected were summed (range 0–11). Responses of "Don't know" and "I have not noticed marijuana being advertised or promoted" were coded as "no exposure to cannabis marketing", and refusals were removed from the analytic sample.

2.3. Statistical analysis

Analyses were conducted using SAS (SAS 9.4, SAS Institute Inc., Cary, NC, USA). A total of 2185 respondents were removed for non-response/refusal for education and noticing cannabis advertisements—the primary dependent variable—for a final analytic sample of 185,388. Estimates were weighted to known population targets based on age-by-sex-by-state, education-by-state, region-by-race, and age-by-smoking status groups where state was grouped for all states with

samples of less than 800 respondents and region refers to the nine US Census Divisions. In waves 1–4 (2018–2021), all non-'recreational' states were grouped together and respondents from those states were weighted separately from those living in 'recreational' states. A raking algorithm was applied to the analytic sample to compute weights that were calibrated to these groupings. Weights were rescaled to the study sample size.

A mixed effects logistic regression model (the 'GLIMMIX' procedure in SAS) was fitted to analyze overall noticing of at least 1 advertisement or promotion in any marketing channel (i.e., 'overall exposure') in the past 12 months (vs. no advertisements or promotions noticed) across policy changes. Descriptive statistics and unadjusted point estimates were used to characterize the sample profile and primary outcomes. Adjusted predicted probabilities based on observed margins were used to characterize age and policy change interactions from the main GLIMMIX model. In a sensitivity analysis, a linear regression model was fitted to Noticing *Index* across policy changes. A secondary analysis was conducted to analyze noticing by legal status of respondents' state (i.e. illegal, medical, or recreational), without a time component. Here, separate GLIMMIX models were fitted to analyze dichotomous noticing via any channel as well as for each of the 11 individual marketing channels by legal status of cannabis. All GLIMMIX models were fitted with a variance component covariance and a random intercept for US state of residence, for which adjusted ORs (AOR), 95 % CIs, and p-values were reported. For the linear regression model, unstandardized betas (b), 95 % CIs and p-values were reported. In all cases, models were adjusted for sex, income adequacy, race, education, cannabis use frequency, and age.

3. Results

3.1. Sample characteristics

Unweighted and weighted sample characteristics are presented in Supplemental Table 1. Across all six survey waves, approximately one third of respondents reported never trying cannabis (34.0 %) while 14.1 % reported consuming cannabis on five or more days per week (consumed 'daily').

3.2. Marketing exposure across policy changes

3.2.1. Main effects

Fig. 1 presents self-reported noticing of at least one cannabis advertisement or promotion in the past 12 months by state-level cannabis policy change status, pooled across 2018–2023. Table 1 shows the findings from the mixed effects logistic regression model. Based on the variance partition coefficient, the random effect of 'state' accounts for approximately 2 % of the variability in noticing cannabis ads. Respondents in illegal states reported the lowest levels of noticing (35.4 %), with higher levels in states after 1 year of medical legalization (39.2 %: AOR=1.16; 95 % CI=1.01–1.33; p = 0.034). From the first year to the 1–3 years following medical legalization, there were modest increases in noticing (42.9 % noticed: AOR=1.12; 95 % CI=0.99–1.27; p = 0.066) with similar levels of noticing in states after 4 or more years of medical legalization (41.1 %). Respondents in states that legalized recreational cannabis reported increased exposure in the first year relative to states after 4 or more years of medical legalization (50.0 % vs. 41.1 % AOR=1.41; 95 % CI=1.34–1.48; p < .001). Further increases were observed 1–3 years following recreational legalization (56.2 % vs.50.0 %: AOR=1.20; 95 % CI=1.14–1.25; p < .001), with additional increases in noticing four or more years after the policy change (63.9 % vs. 56.2 %: AOR=1.21; 95 % CI=1.16–1.27; p < .001).

3.2.1.1. Survey year.
Noticing cannabis advertising differed by survey wave, after adjusting for policy change status. Following an initial increase from 2018 (45.2 %) to 2019 (56.2 %: AOR=1.27; 95 % CI=1.22–1.33; p < .001), marketing exposure decreased in 2020 relative to 2019 (46.6 %: AOR=0.71; 95 % CI=0.69–0.74; p < .001), coinciding with the COVID-19 pandemic. Following this decrease, self-reported cannabis marketing exposure increased in 2021 (50.0 % noticed: AOR=1.17; 95 % CI=1.12–1.21; p < .001) and 2022 (54.0 % noticed: AOR=1.12; 95 % CI=1.09–1.16; p < .001), followed by a modest decrease in 2023 (54.3 % noticed: AOR=0.93; 95 % CI=0.91–0.96; p < .001).

3.2.1.2. Cannabis use frequency.
Frequency of cannabis consumption was also associated with noticing cannabis advertising. Respondents who reported never consuming cannabis reported the least cannabis marketing exposure (45.4 %), whereas respondents that consumed daily reported the greatest exposure (59.8 %: AOR=1.62; 95 %
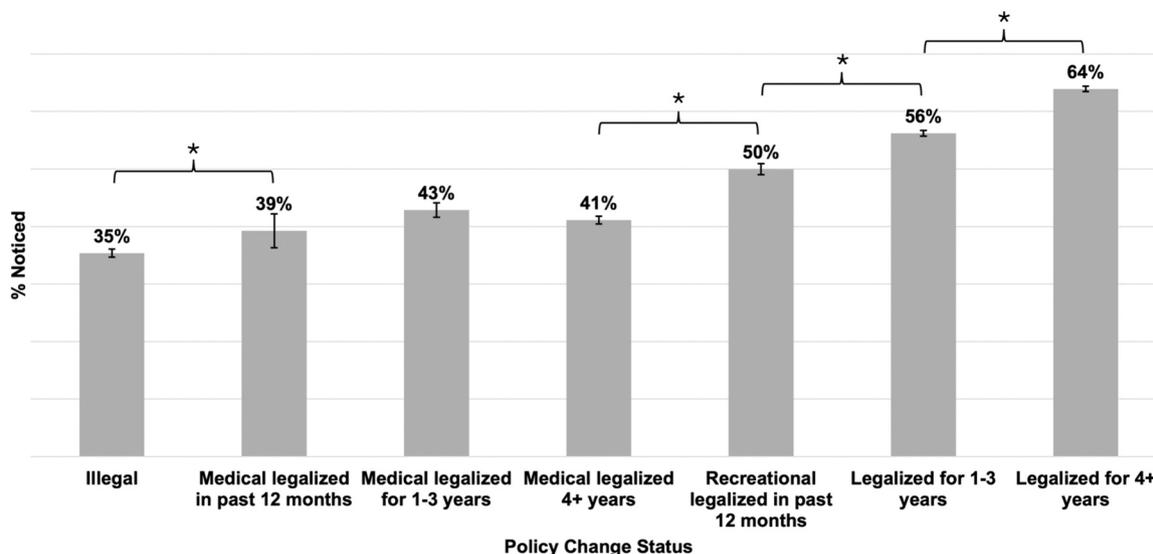
Fig. 1. Past-12-month noticing of at least one cannabis advertisement or promotion across policy changes (n = 185,388). Note. Asterisks indicate the level of statistical significance, where *=p ≤ 0.05.

Table 1

Mixed effects logistic regression for noticing cannabis advertising across policy changes (n = 185,388).

	Unadjusted % Noticed	AOR (95 % CI)	P-value
Policy change status of cannabis			
Illegal	35.4 %	Ref	Ref
Medical legalized in past 12 months	39.2 %	1.16 (1.01, 1.33)	0.034
Medical legalized for 1–3 years	42.9 %	1.30 (1.17, 1.45)	< 0.001
Medical legalized for 4 + years	41.1 %	1.30 (1.18, 1.45)	< 0.001
Recreational legalized in past 12 months	50.0 %	1.83 (1.65, 2.04)	< 0.001
Recreational legalized for 1–3 years	56.2 %	2.19 (1.97, 2.45)	< 0.001
Recreational legalized for 4 + years	63.9 %	2.66 (2.35, 3.01)	< 0.001
Survey year			
2018/Wave 1	45.2 %	Ref	Ref
2019/Wave 2	56.2 %	1.27 (1.22, 1.33)	< 0.001
2020/Wave 3	46.6 %	0.91 (0.87, 0.95)	< 0.001
2021/Wave 4	50.0 %	1.06 (1.02, 1.11)	0.009
2022/Wave 5	54.0 %	1.19 (1.14, 1.25)	< 0.001
2023/Wave 6	54.3 %	1.11 (1.06, 1.17)	< 0.001
Age			
16–20 years	51.8 %	Ref	Ref
21–30 years	60.7 %	0.90 (0.86, 0.94)	< 0.001
31–50 years	53.6 %	0.64 (0.61, 0.67)	< 0.001
51–65 years	44.0 %	0.44 (0.42, 0.46)	< 0.001
Frequency of cannabis use			
Never consumed	45.4 %	Ref	Ref
Consumed more than 12 months ago	51.9 %	1.38 (1.34, 1.41)	< 0.001
Consumed less than monthly, but in the past 12-months	52.8 %	1.22 (1.17, 1.26)	< 0.001
Consumed monthly to weekly	59.5 %	1.56 (1.51, 1.61)	< 0.001
Consumed daily	59.8 %	1.62 (1.57, 1.68)	< 0.001
Sex at birth			
Female	48.6 %	0.79 (0.77, 0.80)	< 0.001
Male	55.0 %	Ref	Ref
Education			
Less than high school	47.1 %	Ref	Ref
High school diploma or equivalent	46.5 %	1.10 (1.06, 1.15)	< 0.001
Some university/college	51.8 %	1.43 (1.37, 1.50)	< 0.001
Bachelor's degree or higher	56.6 %	1.84 (1.76, 1.93)	< 0.001
Race			
White (non-Hispanic)	50.5 %	Ref	Ref
White (Hispanic)	60.9 %	1.31 (1.27, 1.36)	< 0.001
American Indian or Alaskan Native	61.2 %	1.24 (1.14, 1.36)	< 0.001
Asian	48.4 %	0.80 (0.76, 0.84)	< 0.001
Black or African American	51.5 %	1.20 (1.16, 1.24)	< 0.001
Native Hawaiian or Pacific Islander	54.5 %	1.26 (1.10, 1.44)	0.001
Other/2 + races	57.5 %	1.17 (1.11, 1.23)	< 0.001
Unstated	47.9 %	0.86 (0.80, 0.94)	< 0.001

Table 1 (*continued*)

	Unadjusted % Noticed	AOR (95 % CI)	P-value
Income adequacy			
Difficult or very difficult	52.4 %	Ref	Ref
Neither easy nor difficult	50.1 %	0.89 (0.87, 0.91)	< 0.001
Easy or very easy	54.7 %	1.02 (0.99, 1.05)	0.125
Not Stated	31.8 %	0.38 (0.36, 0.41)	< 0.001
Variance of random intercept			
τ^2	0.0617		
VPC[a]	0.0184		

Note. Adjusted ORs may differ from unadjusted point estimates due to inclusion of covariates in model

[a] VPC variance partition coefficient

CI=1.57–1.68; p < .001).

3.2.1.3. Sociodemographic factors. Differences observed by sex-at-birth, age, education, race, and income adequacy were also statistically significant. Respondents that were female-at-birth reported lower marketing exposure relative to males-at-birth (48.6 % vs. 55.0 %: AOR=0.79; 95 % CI=0.77–0.80; p < .001). After adjusting, noticing marketing was most likely among the youngest respondents aged 16–20 (51.8 %) and then decreased with age, with the lowest marketing exposure associated with the oldest age group (51–65 years; 44.0 % noticed: p < .001 for all contrasts). Self-reported noticing was lowest among respondents who had not completed high school (47.1 % noticed) and increased with educational attainment (56.6 % noticed among respondents with a Bachelor's degree or higher: p < .001 for all contrasts). Relative to non-Hispanic Whites (50.5 %), cannabis marketing exposure in adjusted models was lowest among respondents that self-identified as Asian and unstated races (48.4 % and 47.9 %, respectively), and greatest among respondents that self-identified as American Indian or Alaskan Native (61.2 %), and Native Hawaiian or Pacific Islander (54.5 %: p ≤ .001 for all contrasts). Relative to respondents that reported it was 'difficult or very difficult' to make ends meet, individuals that stated it was 'easy or very easy' reported similar levels of noticing (54.7 % vs. 52.4 %), whereas respondents with income adequacy not stated reported the lowest cannabis marketing exposure (31.8 %; p < .001).

3.2.2. Policy change status and age interactions

A two-way interaction between policy change status and age was statistically significant (F=19.5, p < .001). As Supplemental Figure 1 shows, there were fewer differences across age groups in states with 'older' recreational laws than in illegal states and most states with medical and 'younger' recreational laws. In addition, noticing cannabis advertising increased to a larger extent among respondents aged 16–20 than among young adults aged 21–30 in recreational markets that were four years or older, relative to 1–3 years after the policy change.

3.2.3. Sensitivity analysis

A sensitivity test used the Noticing *Index* variable corresponding to the number of channels in which respondent's noticed cannabis marketing (range 0–11). Trends in Noticing *Index* were similar to the binary outcome, reported above, for trends following recreational legalization (see Supplemental Table 5). However, findings differed for noticing across medical cannabis policy changes. Relative to the illegal jurisdictions (Mean=0.70), the mean number of channels noticed was similar in the first year following medical legalization, but increased from the first year to one to three years after the policy change (Mean=0.79 and Mean=0.90: b=0.10; 95 % CI=0.02–0.19; p = 0.019, respectively), before stabilizing from four years, onwards (Mean=0.86). After adjusting for covariates, being aged 16–20 was associated with the greatest

mean number of channels noticed in the adjusted linear model (Mean=1.21), relative to all other age groups (p ≤ .001 for all contrasts).

3.3. Differences in exposure by legal status

A secondary analysis was conducted to examine noticing by cannabis laws, without accounting for the time since implementation (i.e., 3 levels: illegal, medical, and recreational). Fig. 2 presents point estimates for marketing exposure across illegal, medical, and recreational states overall and by channel. As shown in Supplemental Table 6, noticing cannabis marketing was higher in medical versus illegal states (41.5 % vs. 35.4 % noticed: AOR=1.25; 95 % CI=1.13–1.38; p < 0.001), with the greatest reported exposure in recreational states (58.9 % vs. 41.5 % in medical states; AOR=1.49; 95 % CI=1.42–1.56; p < .001).

3.3.1. Marketing exposure by channel

Respondents reported high levels of noticing cannabis promotions in retail settings and digital media channels, with notable differences based on cannabis laws (see Fig. 2). Respondents living in recreational states reported higher levels of noticing cannabis in all 11 marketing channels (see Supplemental Tables 7–17), particularly for noticing inside and outside stores, and via billboards or posters. Levels of noticing were similar between medical and illegal states for marketing via postal mail, event sponsorships, and billboards or posters; however, for all other channels, exposure was greater in medical versus illegal states (p ≤ .03 for all contrasts). Across all states, cannabis use frequency was associated with differences in cannabis marketing exposure. Respondents that consume cannabis daily reported higher levels of exposure compared to respondents that never consumed cannabis for all channels except marketing outside stores, where using cannabis at least once per month was associated with lower noticing (p≤.006 for all contrasts).

Levels of exposure in specific marketing channels differed by age in adjusted regression models (see Supplemental Tables 7–17). As shown in Fig. 3, respondents 16–20 years of age were more likely to report noticing marketing outside stores, via social media, billboards or posters, and websites (p < .001 for all contrasts with other age groups).

Respondents aged 21–30 years reported similar levels of cannabis marketing exposure to respondents aged 16–20 for marketing inside stores, via email or texts, and at events; whereas respondents 31 years and older reported lower levels of exposure (p ≤ .015 for all contrasts). Exposure among respondents aged 21–30 years was higher than that among respondents aged 16–20 for noticing via postal mail (p = 0.002), in bars, pubs, or nightclubs (p = 0.002), and via TV or radio (p = 0.025).

4. Discussion

The current study addresses an important gap in the literature on cannabis legalization and the reach of cannabis advertising in US states. The findings demonstrate substantial long-term increases in self-reported exposure to cannabis advertising and promotions following legalization of both medical and recreational cannabis. The magnitude of these differences is notable: nearly twice as many respondents reported exposure to cannabis marketing in established recreational markets compared to states in which cannabis was illegal. The current findings align with previous research indicating much higher exposure in recreational states relative to medical and illegal states (Krauss et al., 2017; Rup et al., 2020). At the same time, the findings highlight the considerable marketing that occurs in medical cannabis markets, which appears to have a broad reach beyond individuals authorized to access medical cannabis (D'Amico et al., 2015). Research assessing population-level marketing exposure in medical markets is limited despite some medical states permitting cannabis marketing (Allard et al., 2023). The current findings suggest that states with medical cannabis markets may need to consider more comprehensive marketing restrictions if protecting young people from promotional information is a policy goal.

Whereas previous studies have largely treated cannabis laws in a binary fashion, the current study highlights the 'maturity' of legal markets as an important factor when considering exposure to cannabis marketing: although changes in exposure were observed within the first year of medical and recreational legalization, exposure increased as the number of years since legalization increased. The relatively rapid increase in cannabis marketing exposure following the creational of legal
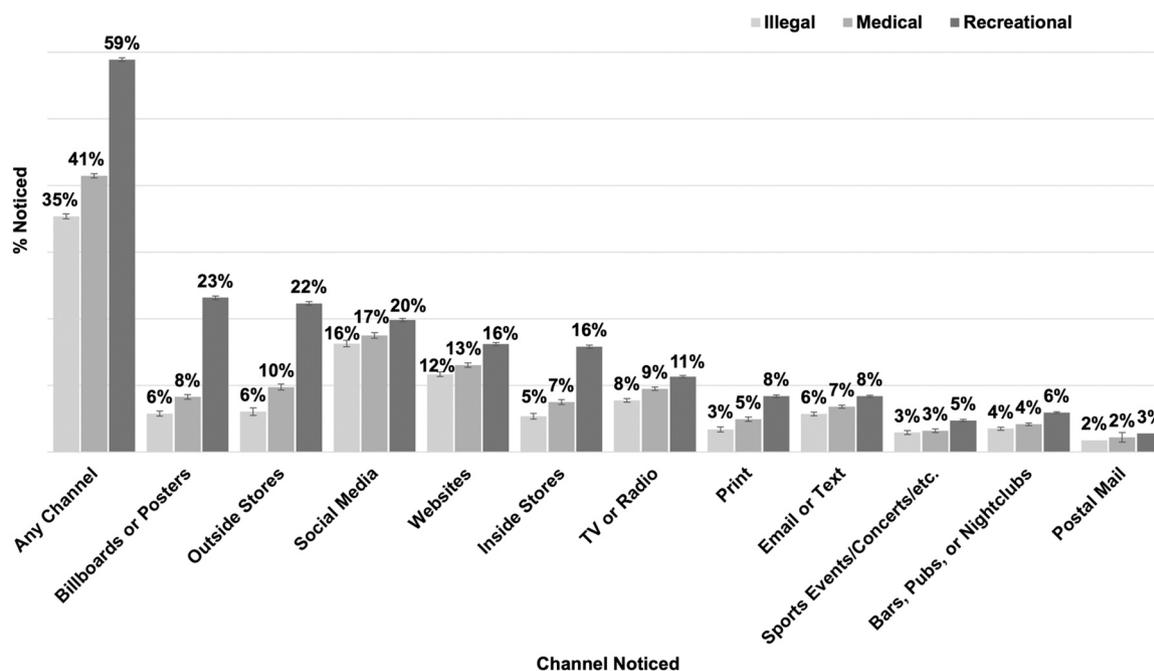

Fig. 2. Past-12-month noticing of at least one cannabis advertisement or promotion across legal statuses by channel.
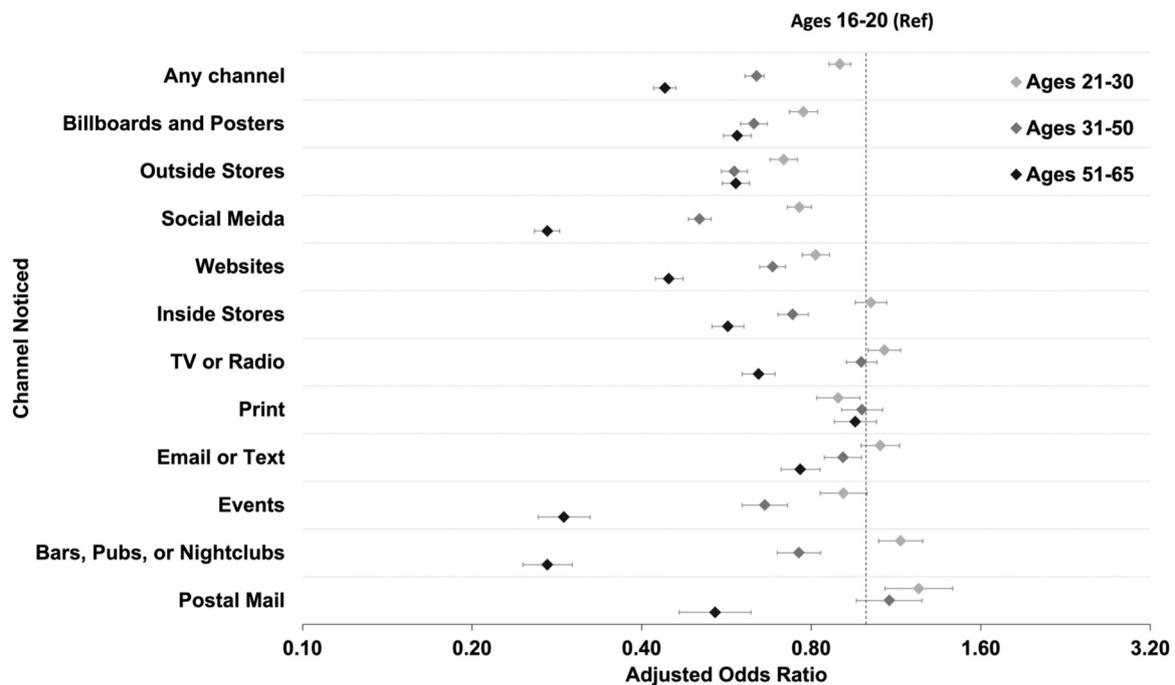
Fig. 3. Adjusted odds ratios for past-12-month noticing of at least one cannabis advertisement or promotion by age group.

markets highlights the importance of developing marketing regulations even prior to the start of legal sales. This presents a challenge, particularly for states in which cannabis laws have been changed through the 'proposition' process and state-ballot measures, which often leave little time for policy planning and development. Meanwhile, the increases in levels of reported exposure over time reflect the evolution of legal markets after the official date of 'legalization'. Indeed, the commercialization process typically occurs over the initial 5 or even 10-year period after cannabis legalization, including changes in the number of licensed stores, product selection, price volatility, and newly established marketing practices (Hammond et al., 2022; National Academies of Sciences, Engineering, and Medicine NASEM, 2017; Wadsworth et al., 2023). Ideally, marketing regulations should evolve with cannabis marketing practices to effectively reduce marketing exposure as markets mature.

Younger respondents were more likely to report noticing cannabis marketing than older respondents. Notably, respondents 16–20 years of age reported even greater exposure to cannabis marketing than respondents aged 21–30 years after adjusting for cannabis use and other sociodemographic variables, but only in states with recreational cannabis laws. In other words, marketing exposure was highest among those below the minimum legal age in recreational states. The results are consistent with previous findings published from the same study (Rup et al., 2020); however, the current study highlights changes that occur as recreational markets mature. This is concerning from a public health standpoint given emerging evidence that exposure to cannabis marketing is associated with greater susceptibility to cannabis use and cannabis use disorder among young people (D'Amico et al., 2018, 2015; Trangenstein et al., 2021), similar to evidence on tobacco marketing and smoking initiation among youth (National Center for Chronic Disease Prevention and Health Promotion US Office on Smoking and Health, 2014; National Center for Chronic Disease Prevention and Health Promotion US Office on Smoking and Health, 2012). These findings may indicate current marketing regulations in legal markets are not sufficient in protecting underaged people from marketing exposure and inducements to use, despite many recreational states enacting audience composition requirements for cannabis marketing to reduce underage

exposure (Allard et al., 2023).

To our knowledge, the current study is among the first to examine differences in the reach of specific marketing channels for cannabis and represents the most comprehensive assessment of channels. The findings suggest that the main sources of cannabis marketing exposure differ for jurisdictions with and without legal recreational cannabis. Much of the marketing exposure in recreational states comes from physical advertisements such as billboards and outside storefronts, whereas in illegal and medical states, digital channels accounted for the highest levels of self-reported exposure. Previous research in the US and Canada has indicated noncompliant cannabis marketing is most common from digital sources, such as social media or websites (Berg et al., 2023; Marinello et al., 2024; Sheikhan et al., 2021). This may be due to 'spillover effects' from legal jurisdictions, where online marketing crosses geographic boundaries. Future studies should consider environmental scans of both 'physical' and virtual sources of cannabis marketing to directly assess the extent of noncompliant marketing practices.

Exposure to marketing was strongly associated with cannabis use. The association between more frequent cannabis use and greater exposure to cannabis marketing is likely bidirectional: exposure to cannabis marketing can induce use, while people who consume cannabis are more likely to seek out and be exposed to cannabis marketing (Chaffee et al., 2024; Noël et al., 2024; Cabrera-Nguyen et al., 2016; Rup et al., 2020; Trangenstein et al., 2021; Whitehill et al., 2020). The current study expands on previous literature by highlighting channels in which this relationship is more pronounced, as well as channels where this is not observed. Respondents who frequently consume cannabis were more likely to report noticing ads inside stores, and via channels such as email or text, websites, social media, and at events. In contrast, there was no clear relationship between exposure and cannabis use for noticing ads via TV or radio, or outside stores. Exposure to cannabis outside stores is particularly important: stores often have extensive brand imagery and promotional information that can be visible by minors from exterior settings. Future research should examine the relative influence of individual channels in inducing cannabis use, particularly among young people who are more vulnerable to marketing (Pechmann et al., 2005).

Younger respondents were also more likely than any other age group to report noticing cannabis marketing from websites, billboards and posters, and social media. These findings are consistent with general trends in which young people have higher levels of engagement with digital information sources, through which both paid and unpaid promotional imagery is common (Duan et al., 2024; Moreno et al., 2022; "Social Media Fact Sheet," 2024). These findings suggest more comprehensive regulations for channels predominantly noticed by young people may reduce overall levels of underaged marketing exposure.

4.1. Limitations

This study has several limitations that warrant consideration. ICPS data are collected via self-reported surveys, and therefore social desirability bias is a concern. At the end of the survey, respondents are asked whether they were able to answer questions truthfully, and respondents that respond "no" are removed from the final sample. Additionally, ICPS uses nonprobability-based sampling which may not necessarily be representative of true population estimates; however, data are weighted to known population targets based on age-by-sex-by-state, education-by-state, region-by-race, and age-by-smoking status groups (Corsetti et al., 2023). Recall bias may be a concern, as respondents may not accurately recall the number or type of cannabis marketing channels to which they were exposed. However, previous studies have demonstrated a strong association between self-reported measures of marketing exposure and objective measures of marketing (Feighery et al., 2006; Southwell et al., 2002). Finally, due to the low prevalence of people identifying as a gender-minority, we were unable to assess gender in the full analytical models. However, descriptive statistics provided in Supplemental Table 18 suggest important differences that warrant further consideration.

5. Conclusions

Marketing plays an important role in promoting substance use, particularly among young people (Trangenstein et al., 2021; Whitehill et al., 2020). To date, there is little empirical evidence on marketing exposure under legal cannabis markets in the US. The current study indicates that both 'medical' and 'recreational' cannabis legalization increases exposure to cannabis marketing. States with more 'mature' cannabis markets were associated with the highest levels of marketing exposure, including from traditional channels such as retail stores and billboards, as well as digital channels. Young people—including youth below the minimum legal age—reported noticing the highest levels of cannabis advertising and promotion. The findings highlight potentially important gaps in marketing restrictions in states that have legalized medical and recreational cannabis. Future research should monitor these trends and examine the effectiveness of advertising regulations in legal markets to inform future policy decisions.

CRediT authorship contribution statement

Lauren Winfield-Ward: Methodology, Conceptualization, Writing – original draft, Investigation, Visualization, Formal analysis. **Vicki L Rynard:** Writing – review & editing, Formal analysis. **David Hammond:** Writing – review & editing, Methodology, Conceptualization, Supervision, Investigation, Resources, Funding acquisition. **Elle Wadsworth:** Conceptualization, Writing – review & editing, Methodology. **Pete Driezen:** Writing – review & editing, Conceptualization, Methodology, Formal analysis.

Declaration of Competing Interest

Acknowledgements

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.drugalcdep.2025.112787.

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