EXPOSURE TO CANNABIS MARKETING IN THE UNITED STATES: DIFFERENCES BY CANNABIS LAWS AND THE STRENGTH OF RESTRICTIONS IN 'RECREATIONAL' CANNABIS MARKETS

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

ABSTRACT

Background: A growing number of U.S. states have legalized adult "recreational" cannabis. Restrictions on advertising and promotions to prevent marketing exposure among vulnerable populations are a key component of cannabis regulations in legal markets; however, there is little evidence on the impact of restrictions to date.

Objectives: To examine differences in exposure to cannabis marketing across U.S. states where cannabis is illegal ('illegal states'), legal for medical use ('medical states'), and legal for recreational use ('recreational states'). This study also examined differences in exposure by the strength of marketing restrictions among recreational states.

Methods: Data are from the U.S. component of the International Cannabis Policy Study: repeat cross-sectional data from national surveys conducted with 187,573 respondents aged 16-65 over 6 annual survey waves (2018-2023). Exposure to cannabis marketing was assessed by asking respondents to report whether they have noticed any cannabis marketing across 11 channels in the past 12 months ('noticing' of cannabis marketing). The 'strength' of marketing restrictions was measured using data sourced from regulatory documents in each recreational state with legal sales and categorized into four strength levels. An index of the strength of marketing restrictions was then created for each recreational state with legal sales. Mixed effects logistic regression models (GLIMMIX) were fitted to analyze differences in self-reported noticing of cannabis marketing across medical and recreational policy changes, as well as by the strength of marketing restrictions in states with legal recreational sales. Analyses also examined exposure measures and associations with sociodemographic factors.

Results: Self-reported exposure to cannabis marketing differed across policy changes. Noticing cannabis marketing was lowest in illegal states, with higher levels of noticing in states in the first 12 months following medical legalization (39.24% vs. 35.37%: AOR=1.16; 95% CI=1.01-1.33; p=0.034). Levels of noticing were higher in the first 12 months following recreational legalization relative to established medical markets (49.96% vs. 41.12%: AOR=1.41; 95% CI=1.34-1.48; p<.001), with additional increases 1-3 years and 4 or more years following the policy change (56.21%: AOR=1.20; 95% CI=1.14-1.25; p<.001, and 63.90%: AOR=1.21; 95% CI=1.16-1.27; p<.001, respectively). Noticing cannabis marketing also differed by the strength of restrictions in recreational states. In states with legal recreational sales, jurisdictions with the high (Level 3) restriction strength reported the lowest exposure to cannabis marketing (53.39% noticed), and exposure was similar across Level 1 and Level 2 restriction states. There was insufficient data to examine long-term trends for restriction levels.

Conclusions: Self-reported exposure to cannabis marketing increases following medical and recreational cannabis legalization. Overall, stronger marketing regulations may reduce exposure in legal markets; however, underaged people report the greatest noticing of cannabis marketing. Research should continue to monitor trends in marketing exposure over time, as more states begin legal recreational sales and legal markets mature.

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1.0 BACKGROUND

1.1 Cannabis and public health

While cannabis is still prohibited at the federal level within the United States, a growing number of states are legalizing medical, and non-medical (recreational) cannabis.[1] State-level cannabis policies across the United States fall into one of three general categories: 'recreational' cannabis states, where both non-medical and medical cannabis is legal for adult use; 'medical' cannabis states where cannabis is only legal if authorized for medical purposes; and 'illegal' states, where the use and sale of all cannabis is illegal, consistent with federal legislature. There are also notable differences within each of the broad categories: for example, some illegal states have exemptions for low-tetrahydrocannabinol (THC) cannabis or have decriminalized possession. Additionally, some medical states provide only limited access to medical cannabis, whereas other medical states provide broad access, including well-established retail stores, similar to some recreational states.

The public health impact of cannabis will be determined not simply by its status as a legal substance, but by how it is regulated in a legal market. The history of tobacco control illustrates the distinction between legalization and the role of regulatory measures within a legal market: tobacco has always been legal in North America, but the way it is regulated has fundamentally changed patterns of use.[2] Restrictions on cannabis advertising and promotions—which will collectively be referred to as 'cannabis marketing' in the current document—is a primary component of the regulatory framework for cannabis products in US states, particularly in regard to policy objectives related to protecting young people from inducements to use cannabis in legal markets.[1,3,4] The following sections will review the evidence on marketing and substance use, as well as the literature specific to cannabis marketing.

1.2 Marketing and substance use

One component of legal cannabis markets in North America is the creation of a largescale cannabis industry along with commercial interests to promote cannabis sales and consumption. The association between marketing of substances and increased consumption is well-established, particularly among young people.[2,5,6] Advertisements and promotions convey positive messages and imagery which minimizes perceptions that a product is harmful and increases perceptions of social acceptability and peer approval—both of which are critically important risk factors for youth initiation of tobacco, e-cigarettes, and alcohol. For example, there is extensive evidence on the causal role of tobacco marketing in smoking initiation among youth and young adults.[2,7] Similar findings have been reported for e-cigarettes, where advertising campaigns for e-cigarettes have proven effective at increasing the prevalence of e-cigarette use or 'vaping'.[5,8] There is also an abundance of evidence indicating exposure to alcohol marketing is associated with increased alcohol consumption and initiation among adolescents.[6]

1.2.1 Observational studies on exposure to cannabis marketing

Early evidence on cannabis marketing in recreational U.S. states consistently demonstrates associations with patterns of use and susceptibility.[9–11] A 2018 cross-sectional study examining

exposure to cannabis marketing among 15- to 19-year-olds found that more than 1 in 10 adolescents reported exposure to some form of cannabis marketing.[9] Notably, there was a positive association between past-year cannabis consumption and reported exposure to cannabis marketing. A similar 2018 study looking only at adolescents (aged 15-19 years) that have used cannabis at least once found high exposure to billboard marketing was associated with increases in frequency of cannabis use and cannabis use disorder.[10] There has been relatively little research on the effects of cannabis marketing among older ages; however, this aligns with findings by Rup et al[11], where national 2018 survey data from U.S. respondents aged 16-65 years indicated increases in frequency of cannabis use correlated with increases in reported noticing of cannabis marketing and brand recall. The relationship between marketing exposure and cannabis use is likely bidirectional. Exposure to marketing can induce use by reducing perceived risk and enhancing positive social norms; at the same time, cannabis consumers are more likely to seek out, and be exposed to cannabis marketing.[9–12]

1.2.2 Experimental studies on cannabis marketing

Experimental research on marketing exposure and cannabis use outcomes is limited; however, evidence from experimental studies examining cannabis product packaging indicates colour and branding can increase the appeal of cannabis products, whereas health warning labels can effectively negate this brand appeal.[13–15] A 2019 experimental study conducted with respondents aged 16-65 from the U.S. and Canada found that including branding and colours on cannabis product packaging significantly increased the appeal of cannabis products.[13] One study examining appeal of cannabis products found more branding on packaging was perceived by study participants to be more appealing to youth and even youth-oriented relative to cannabis packaging with less branding.[14] An experiment examining the content of branded cannabis packaging found celebrity sponsorships, and music and party references were also perceived as intended for younger audiences.[16] Overall, experimental findings are generally consistent with the observational literature indicating associations between exposure to cannabis marketing in the form of branding imagery and promotion, and the appeal of cannabis products among both adults and youth.

1.3 Marketing channels for advertising and promotion of cannabis

Several studies have examined marketing practices in states that have legalized medical and recreational cannabis. Various channels are used to advertise and promote cannabis, including traditional media such as billboards and posters, and digital media such as websites and social media such as Instagram, and Facebook.[9,17,18] Notably, digital media can use targeted marketing where algorithms target users with personalized advertising and promotions based on their online behaviour. However, as is the case for alcohol marketing, these algorithms do not effectively prevent cannabis marketing from reaching vulnerable or underaged users.[9,17,19] Social media also often have their own policies around cannabis advertising and promotion as privately owned companies.[20] Advertising and promotion practices therefore differ greatly from one social media platform to another.[18,20–22]

The use of social media for cannabis marketing presents a challenge for restricting access to those that are underage. One study found that 97% of adolescents in states where recreational

cannabis is legal reported noticing some kind of cannabis marketing, with nearly 90% reporting noticing ads on social media, specifically.[9] Nearly 9 in 10 Americans will have used social media by the age of 18, and over a third by the age of 13.[23] It is important to not only understand exposure to cannabis marketing through these channels, but also how this marketing could appeal to and promote engagement with youth and adolescents. Adolescent engagement with cannabis marketing on social media is associated with increased past-year cannabis use and past-28-day cannabis use, as well as increased symptoms of Cannabis Use Disorder.[17,24]

While there is a clear relationship between exposure to marketing and increases in cannabis use measures, the effect of the marketing channel or media used is less clear. Evidence from the 2018 cross-sectional study of adolescent 'lifetime' cannabis users discussed above[10], indicated the odds of Cannabis Use Disorder and frequent cannabis use (using cannabis at least 4 times per week) were over 5 and 7 times greater, respectively, among those who reported seeing cannabis billboards most of the time or always when compared to adolescents that never saw cannabis billboards.[10] In the same study, exposure to cannabis promotion on Facebook had no association with use; however, exposure on Instagram had a modest but significant association with more frequent use.[10] A different cross-sectional study also examining adolescents found Instagram was associated with the highest odds of past-year cannabis use, followed by Facebook and Twitter; however, there was no association for exposure to outdoor advertising such as billboards.[9] Overall, there is a lack of evidence on cannabis marketing through specific marketing channels, with inconsistent findings among the existing studies.

1.4 State-level policy approaches for cannabis marketing

Restrictions on marketing are a central component of regulatory frameworks for legal substances such as tobacco, e-cigarettes, and alcohol. For example, restrictions on tobacco marketing are one of the core 'articles' in the global treaty for tobacco control.[25] There is extensive evidence that marketing restrictions on tobacco products have been effective in reducing tobacco use, particularly among young people.[2,26,27] Similarly, comprehensive marketing restrictions reduce exposure to positive messages and imagery communicated through advertisements and promotions during key transitional periods, including early experimentation among youth and transitions to regular use among adults.[28–30] Although there is less evidence in other domains—such as alcohol—due to a lack of regulatory action, the scientific literature is broadly consistent with the tobacco control literature.

Cannabis products and by extension, cannabis marketing, are currently prohibited at the federal level within the United States. Meanwhile, marketing restrictions among states that have legalized medical and recreational cannabis are highly variable. A scan of policies was conducted in June of 2021 among the 31 states that had legalized medical or recreational cannabis.[31] Advertisements that target or appeal to minors were prohibited in approximately three-quarters of states. Two-thirds of states had regulations prohibiting false claims, while approximately one-third of states prohibited coupon promotions, marketing that depicts characters, and marketing that promotes health and/or cosmetic benefits. Fewer than half of states also restricted the physical locations of advertisements, dispensary building signage, and digital media advertising.

1.5 Differences in exposure to cannabis marketing by cannabis laws

Few studies have examined exposure to cannabis marketing in non-recreational jurisdictions or differences between states with different cannabis laws. Survey data collected from 2010 to 2011 of Southern California youth in grades 6 to 8 indicate nearly one-third reported noticing at least one medical cannabis advertisement in the past three months.[32] Furthermore, youth who reported noticing medical cannabis advertising were twice as likely to use cannabis one year later.[32]

Preliminary research also suggests that exposure to cannabis marketing may be higher in recreational versus medical cannabis markets. Survey data from 2014-2015 of respondents aged 18-34 that have used cannabis in the past month found 47% of respondents in states where only medical cannabis is legal reported they saw or heard a cannabis advertisement in the past 30 days, compared to 66% where non-medical (recreational) cannabis was legal, and 46% where no form of cannabis use was legal.[33] Additionally, the study by Rup et al[11] shows that 34% of respondents in illegal or medical states reported noticing a cannabis advertisement or promotion within the last 12 months, compared to 57% of respondents in states where recreational cannabis is legal. This may be reflective of either marketing from the illegal or medical cannabis market.

1.6 Proximity to cannabis retailers and cannabis outcomes

Retail stores represent an important source of marketing in virtually all commercial domains. Several studies suggest that the presence of 'brick and mortar' retail stores in legal cannabis markets may serve an important promotional function. Findings by Rup et al[11] indicated proximity to retail stores was associated with greater brand recall. A survey of Oregonian adults conducted from 2015-2017—immediately following recreational legalization in the state—found more than half of respondents living in counties with recreational cannabis sales reported past-30-day exposure to cannabis advertising, compared to less than 1 in 3 respondents living in counties without recreational sales.[34] However, a study of adolescents living in Washington and Oregon (with recreational cannabis markets) found that while recreational legalization was associated with increased cannabis use, the number of cannabis retail stores within a 2-, 5-, 10-, and 20-mile radius was not associated with increased cannabis use among adolescents.[35] A 2017 survey of Oregonian 8th and 11th graders, which also examined the association between proximity to cannabis retailers and cannabis use outcomes, found that attending a high school within 1 mile of a cannabis retailer was associated with increased use among respondents in grade 11, but not in grade 8.[36] Self-reported storefront advertising exposure was associated with lower perceived harm for cannabis and increases in all forms of cannabis use among grade 8 students (edibles, dabbing, vaping, and smoking). Meanwhile, exposure to storefront advertising was associated with increases in only some forms of cannabis use among grade 11 students (edibles, dabbing, and vaping).

1.7 Differences in marketing exposure by population subgroup

Levels of exposure and noticing cannabis marketing differ across subgroups.[11,33] Some studies found men more likely to notice advertising and promotion of cannabis, as well as more likely to recall specific cannabis brands than women[11]; however, men that consume cannabis are also

more likely to seek advertisements than women that consume cannabis.[33] Conversely, a 2019 study of cannabis-naïve young adults in Los Angeles, California found that women were more likely than men to recall seeing cannabis marketing online.[37] The same study also reported individuals that identify as lesbian, gay, or bisexual were more likely to recall seeing cannabis marketing online.[37] Exposure to cannabis marketing does not appear to differ by race; however, Rup et al[11] found that individuals who identified as a visible minority were less likely to recall cannabis brands than those that did not. Individuals who reported low levels of perceived income reported greater exposure to cannabis advertising than those with higher perceived income in adjusted models; however, the opposite was true for brand recall, where higher income was associated with greater brand recall for cannabis brands.[11] Lower education was also associated with lower cannabis advertising exposure than higher education, based on measures of both noticing and brand recall.[11]

Exposure to cannabis advertising differs by age group, with teens more likely to notice cannabis advertisements than adults over 35 years of age, but less likely to recall specific brands than adults.[11] Evidence from Rup et al[11] indicated that, among the youngest respondents (aged 16-20 years), nearly 1 in 2 noticed some form of cannabis marketing in the past 12 months.[11] Notably, this age group is under the minimum legal age in the United States (with a minimum legal age of 21 years in all recreational states). Adolescents are also particularly vulnerable to advertising and promotion.[38] Cross-sectional and longitudinal data on exposure to cannabis advertising among adolescents and young adults has consistently demonstrated associations with increased cannabis use, lower perceived harm, and earlier initiation of cannabis use.[9,32,36] In addition to greater vulnerability to advertising and promotion in general, this age group is at an increased risk for cannabis-related health effects and may be more susceptible to problematic substance use.[38–40]

1.8 Summary

An increasing number of US states are legalizing medical and recreational cannabis.[1,3] The impact of legalization on exposure to cannabis marketing—and the effectiveness of regulatory measures in protecting young people from cannabis advertising and promotions—remains unclear. Despite demand reduction policies directed towards preventing cannabis consumption among youth[3], there is considerable evidence that cannabis advertisements are promoting cannabis in ways that appeal to youth.[18] The literature to date suggests that exposure to marketing may be higher in recreational states; however, there is only a limited number of population-based studies conducted with a subset of states that have legalized recreational cannabis. Studies to date also suggest that exposure to cannabis marketing is associated with a higher likelihood of use among young people and various indicators of problematic substance use.[5,9–12] However, this relationship between noticing cannabis advertising and cannabis use is likely bidirectional: exposure to marketing can increase susceptibility to use cannabis by minimizing perceived risk and enhancing positive social norms; at the same time, cannabis consumers are also more likely to seek out, and be exposed to cannabis marketing.[9–12]

Currently, literature surrounding cannabis marketing exposure is limited almost exclusively to adolescents and young adults, with very little population-level data on marketing exposure

among more diverse age groups. There is also a need for more robust studies to examine changes over time within states that legalized recreational cannabis, including 'pre-post' measures over time and comparisons with states that have not legalized recreational cannabis. Finally, there is a need to examine differences in regulatory restrictions among states that have legalized recreational cannabis, to examine whether the 'strength' of marketing restrictions can be effective in achieving policy objectives, including protecting young people from inducements to use cannabis.

2.0 SPECIFIC AIMS

The overall objective of this thesis is to examine levels of exposure to cannabis promotions in the United States, and differences in exposure based on cannabis laws and the strengths of regulations in states that have legalized recreational cannabis. These research objectives will be explored in five research questions:

1. Does noticing cannabis marketing differ across policy status in U.S. states?
   Hypothesis 1: Levels of noticing will be highest after recreational legalization, and lowest in illegal states, with slight increases after medical legalization.
2. Are differences in the strength of marketing restrictions in states with legal recreational cannabis sales associated with different levels of noticing cannabis marketing?
   Hypothesis 2a: Overall levels of noticing will be highest in recreational states with less restrictive cannabis promotion regulations.
   Hypothesis 2b: Levels of noticing in individual channels will be highest in recreational states with higher restriction strength for those channels.
3. How does noticing cannabis advertising differ by sociodemographic variables: sex at birth, income adequacy, race/ethnicity, education, cannabis use frequency, and age?
   Hypothesis 3: Levels of noticing will be highest among respondents that are male at birth, low income adequacy, White, lower education, and young people over the legal age of consumption.
4. How does noticing of cannabis marketing differ over time after the start of legal sales?
   Hypothesis 4a: Noticing cannabis marketing will increase over time after legal sales begin.
   Hypothesis 4b: Noticing cannabis marketing will increase more over time after legal sales begin in low restriction states.

3.0 METHODS

3.1 Study Design

This study was a repeat cross-sectional design using population-based national surveys conducted in the U.S. 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 are recruited through the Nielsen Consumer Insights Global Panel and their partners' panels. The Nielsen panels are 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 minutes in 2018, 25 minutes in 2019, 21 minutes in 2020, 22 minutes in 2021, 23.3 minutes in 2022, and 22.2 minutes in 2023.[41] 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.[42]

3.2 Analytic Sample

The current study includes 6 waves of ICPS data from respondents residing within the U.S., for an overall sample size of 187,573 eligible respondents (17,112 in 2018; 30,407 in 2019; 29,900 in 2020, 30,081 in 2021, 40,420 in 2022 and 39,653 in 2023). A total of 2,185 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.

3.3 Measures

3.3.1 Sociodemographics

Respondents provided sociodemographic information, including sex at birth, age, ethnicity, highest education level, perceived income adequacy, and state of residence. Respondents were classified into 1 of 4 age groups: 16-20 years, 21-30 years, 31-50 years, and 51-65 years. Ethnicity/race was assessed with U.S.-specific measures drawn from the census or benchmark health surveys. Income adequacy, a measure that is associated with objective measures of income and wealth[42], was used as a measure of income, assessed by asking respondents "Thinking about your family's income, how difficult or easy is it to make ends meet?" (on a 5-point Likert scale ranging from 'Very difficult' to 'Very easy').

3.3.2 Cannabis use status

Respondents were classified into five categories based on frequency of cannabis use (medical or recreational): 'Never consumer', 'Consumed more than 12 months ago', 'Past-12-month consumers', 'Monthly consumer and Weekly consumers', and 'Daily consumers'.

3.3.3 Medical authorization status

Among those who have ever used cannabis in recreational and medical states, respondents were further classified into 3 categories based on medical authorization status: 'Never authorized', 'Ever authorized' (where they had been previously authorized to use medical cannabis but not within the last 12 months), and 'Currently authorized' (where they had been authorized to use medical cannabis within the last 12 months).

3.3.4 Policy status and time since legal sales began

Variables for 'policy status' and 'time since legal sales began' are time-varying at the level of state. Respondents were classified into seven categories based on the cannabis policy status in their state of residence at the time of data collection: 'Illegal' (where use and possession of both medical and recreational cannabis is generally prohibited), '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'. Analyses of states with legal sales used similar groupings based on time since legal sales began. As Table A1 shows, 6 states implemented medical cannabis laws during the period of data collection, and 14 implemented recreational laws.

3.3.5 Strength of state advertising restrictions

Respondents residing in recreational states with legal retail sales (i.e. state-regulated retail stores) were further classified based on strength of advertising restrictions within their state. State regulations were reviewed as of April 2024 for advertising and promotion of recreational cannabis from each recreational state, to identify relevant restrictions for each of 11 marketing channels (see Table A4 for included channels). For each recreational state, regulations for individual marketing channels were independently scored by two reviewers based on strength of the state's marketing restrictions and summed for a total state score (see Table A5). Individual channel scores were calculated as: Level 1=low strength level, Level 2=low-moderate strength level (some restrictions for products only), Level 3=moderate strength level (comprehensive restrictions for products only), Level 4=moderate-high strength level (some restrictions for both advertising and branding), and Level 5=high strength level (comprehensive restrictions for both advertising and branding). Noticing via individual marketing channels was analyzed using all available restriction levels; however, some channels were missing data for one or more restriction levels. Total state scores—the sum of all channel scores within that state—will be analyzed as a categorical variable. Total state scores were categorized into 3 restriction levels for analyses: Level 1=low strength level with a total score between 11 and 33, Level 2=moderate strength level with a total score between 34 and 39, and Level 3=high strength level with a total score between 40 and 55. See Table A4 for more information on the classification criteria.

3.3.6 Noticing cannabis advertising

'Noticing cannabis advertising' or self-reported exposure, 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 one or more of the following channels: (1) Regular postal mail; (2) Websites; (3) Email or text messages; (4) Bars, pubs, or nightclubs; (5) Inside

stores that sell marijuana; (6) Outside stores that sell marijuana; (7) Pharmacies; (8); Events like sporting events, concerts, festivals or markets; (9) Kiosks or temporary sales locations (in shopping centers or on the street); (10) TV or radio; (11) Billboards or posters; (12) Print newspapers or magazines; (13) At the movies; (14) Taxis or buses/public transit; (15) Flyers; (16) Social media, like Facebook, Twitter, YouTube, Instagram or Snapchat; (17) Other (with the option to type a specification); (18) I have not noticed marijuana being advertised or promoted; (19) Don't know; (20) Refuse to answer; and/or an open-ended response option. Response options for 11 channels: regular postal mail; websites; email or text messages; bars, pubs, or nightclubs; inside stores that sell marijuana; outside stores that sell marijuana; events like sporting events, concerts, festivals or markets; TV or radio; billboards or posters; print newspapers or magazines; and social media, were recoded into both a dichotomous response variable (0=no advertisements noticed vs. 1=at least one advertisement noticed). An index variable was also created for the mean number of channels noticed (noticing *Index*). Responses of "Don't know" and "I have not noticed marijuana being advertised or promoted" will be coded as "no exposure to cannabis marketing", and refusals were removed from the analytic sample.

3.4 Analysis

3.4.1 Data sources and procedures

Analyses were conducted using SAS (SAS 9.4, SAS Institute Inc., Cary, NC, USA). Estimates were weighted similar 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 small samples and region refers to the nine US Census Divisions (New England, Middle Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain or Pacific). Respondents were weighted separately by legal status of cannabis in their state of residence from waves 1 to 4 (2018-2021). A raking algorithm was applied to the analytic sample to compute weights that were calibrated to these groupings. All analyses used weights rescaled to the study sample size.

3.4.2 Analysis plan

Descriptive statistics and unadjusted point estimates were used to characterize the sample profile and primary outcomes. As described below, 14 separate mixed effects logistic regression models were fitted with a variance component covariance structure and a random intercept for state, for which adjusted ORs, 95% CIs, and p-values were reported. One linear regression model was fitted to noticing *Index*, for which adjusted betas, 95% CIs, and p-values were reported. In all cases, models included the following covariates: sex, income adequacy, race/ethnicity, education, cannabis use frequency, and age.

3.4.2.1 Differences in noticing cannabis advertising between illegal, medical, and recreational states

Differences in noticing across policy changes were analyzed using a mixed effects logistic regression model (using PROC GLIMMIX in SAS) with a random intercept for US state of residence. The model was fitted to analyze noticing via any marketing channel as a dichotomous outcome variable (0=no advertisements noticed vs. 1=at least one advertisement noticed). A

sensitivity analysis was conducted using an identical model fitted to analyze legal status of respondents' state (i.e. illegal, medical, or recreational).

3.4.2.2 Differences in noticing cannabis advertising within recreational states

Differences in noticing cannabis advertisements in states with legal sales were analyzed two ways. First, a mixed effects logistic regression model with a random intercept for US state was fitted to analyze noticing via any marketing channel as a dichotomous outcome variable (0=no advertisements noticed vs. 1=at least one advertisement noticed), with pairwise contrasts of state restriction score categories. Sensitivity analyses were conducted using a linear model with the PROC SURVEYREG procedure, fitted to analyze noticing *Index*–the summed number of marketing channels where cannabis advertising was noticed–with pairwise contrasts of individual channel restriction levels. In a second set of analyses, a separate mixed effects logistic regression model for each marketing channel was fitted to analyze noticing via that channel, again with a random intercept for US state. All models for legal sales states also included the time since legal sales began.

4.0 RESULTS

4.1 Sample characteristics

Unweighted and weighted sample characteristics are presented in Table 1. Across all six survey waves, respondents from states with legal recreational cannabis represented a majority of the weighted study population (64.4%), with approximately half of respondents residing in states with legal recreational sales (53.2%). Approximately one third of respondents reported never trying cannabis (34.0%), and among those that had ever consumed cannabis, most were never authorized for medical cannabis use (86.8%). Approximately a tenth of the sample comprised respondents aged 16-20, whom are 'underaged' under recreational cannabis laws (10.3%).

Table 1. Sample Characteristics

	Unweighted, n (%) n=185,388	**Weighted, n (%)** n=185,388
Survey year		
2018/Wave 1	17019 (9.17%)	17104 (9.23%)
2019/Wave 2	30141 (16.24%)	30111 (16.24%)
2020/Wave 3	29423 (15.85%)	29337 (15.82%)
2021/Wave 4	29654 (15.97%)	30164 (16.27%)
2022/Wave 5	39951 (21.55%)	39728 (21.43%)
2023/Wave 6	39200 (21.12%)	38943 (21.01%)
Legal status of cannabis		
Recreational	120031 (64.75%)	119415 (64.41%)
Medical	38438 (20.98%)	38677 (21.07%)
Illegal	26919 (14.27%)	27296 (14.52%)
Residing in states with legal sales		
No	86256 (46.53%)	86793 (46.82%)
Yes	99132 (53.47%)	98595 (53.18%)
Frequency of use		
Never consumer	62310 (33.61%)	63064 (34.02%)
Consumed more than 12 months ago	59919 (32.32%)	56448 (30.45%)
Past-12-month consumer	17784 (9.59%)	17074 (9.21%)
Monthly to weekly consumer	21219 (11.45%)	22584 (12.18%)
Daily Consumer	24156 (13.03%)	26218 (14.14%)

Medical authorization among consumers		
Never authorized	107430 (87.67%)	105663 (86.83%)
Ever authorized[a]	5303 (4.33%)	5456 (4.48%)
Currently authorized	9803 (8.00%)	10571 (8.69%)
Age		
16-20 years	17475 (9.43%)	19146 (10.33%)
21-30 years	27808 (15.00%)	34312 (18.51%)
31-50 years	73921 (39.87%)	75705 (40.84%)
51-65 years	66184 (35.70%)	56225 (30.33%)
Sex at birth		
Female	127729 (68.90%)	92628 (49.96%)
Male	57659 (31.10%)	92760 (50.04%)
Education		
Less than high school	15547 (8.39%)	16508 (8.90%)
High school diploma or equivalent	35208 (18.99%)	39478 (21.29%)
Some college or technical/vocational training or certificate/diploma, or apprenticeship, or some university	64722 (34.91%)	69026 (37.23%)
Bachelor's degree or higher	69911 (37.71%)	60376 (32.57%)
Ethnicity		
White (non-Hispanic)	132352 (71.39%)	127130 (68.57%)
White (Hispanic)	14370 (7.75%)	16279 (8.78%)
American Indian or Alaskan Native	2484 (1.34%)	2370 (1.28%)
Asian	8405 (4.53%)	7683 (4.14%)
Black or African American	15593 (8.41%)	20960 (11.31%)
Native Hawaiian or Pacific Islander	1057 (0.57%)	1010 (0.54%)
Other/2+ races	8109 (4.37%)	7178 (3.87%)
Unstated	3018 (1.63%)	2778 (1.50%)
Income adequacy		
Difficult or very difficult	61650 (33.25%)	59887 (32.30%)

Neither easy nor difficult	60497 (32.63%)	61056 (32.93%)
Easy or very easy	58348 (31.47%)	59112 (31.89%)
Not Stated	4893 (2.64%)	5332 (2.88%)

[a]Ever authorized: reported receiving medical cannabis authorization previously, but were not authorized at any time in the last 12 months

4.2 Marketing exposure across policy changes

4.2.1 Main effects

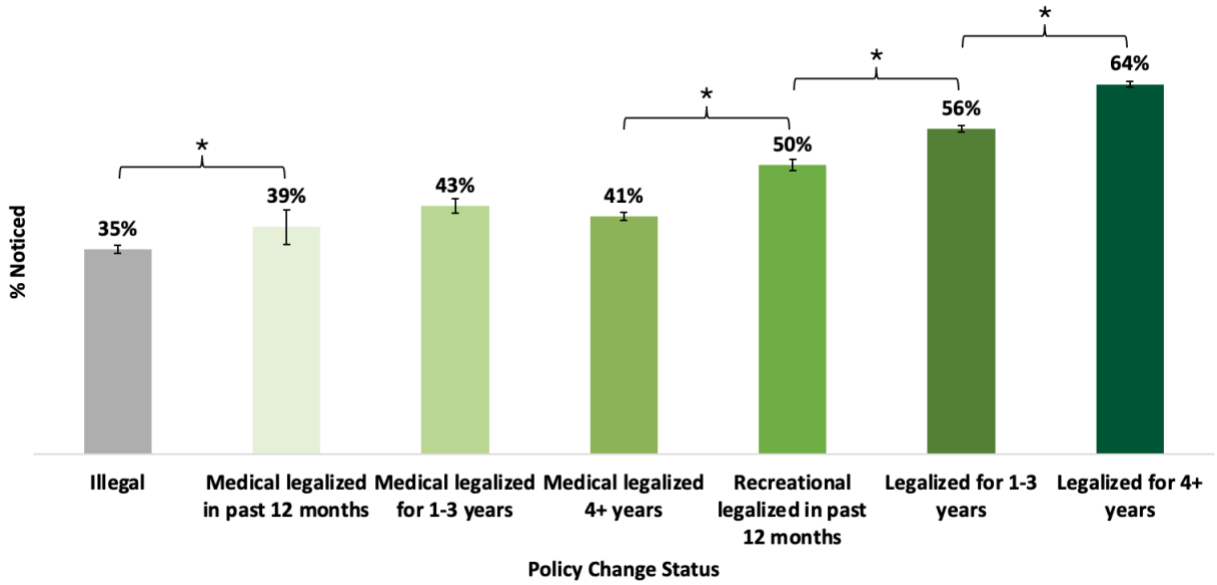
Figure 1 presents self-reported noticing of at least one cannabis advertisement or promotion in the past 12 months, across state policy changes. Table 2 presents regression results for noticing at least one cannabis advertisement or promotion in the past 12 months across all states. The variance of the random intercept 'state' (denoted by τ^2) indicates there is some state-level variation in noticing after adjusting for other covariates. 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% noticed), followed by an increase the first year following 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 was a modest increase in noticing after adjusting (42.9% noticed: AOR=1.12; 95% CI=0.99-1.27; p=0.066); this trend then stabilized with little change four or more years after the policy change (41.1%). States that legalized recreational cannabis reported increased exposure in the first year relative to established medical markets (50.0% vs. 41.1% noticed: AOR=1.41; 95% CI=1.34-1.48; p<.001). This initial increase was followed by another relative increase in the 1-3 years following legalization (56.2% noticed: AOR=1.20; 95% CI=1.14-1.25; p<.001), and further increases four or more years after the policy change (63.9% noticed: AOR=1.21; 95% CI=1.16-1.27; p<.001).

Noticing cannabis advertising also differed by survey wave, or year. Following an initial increase from 2018 (45.2% noticed) 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% noticed: 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 slight decrease in 2023, after adjusting for covariates (54.3% noticed: AOR=0.93; 95% CI=0.91-0.96; p<.001).

Frequency of cannabis consumption was associated with noticing cannabis advertising. Respondents who reported never consuming cannabis reported the least cannabis marketing exposure (45.4%), whereas frequent consumers that consumed daily reported the greatest exposure (59.8% noticed: AOR=1.62; 95% CI=1.57-1.68; p<.001).

Figure 1. Noticing cannabis ads across policy changes



Note. Asterisks indicate the level of statistical significance, where *=p≤0.05.

The effect of medical authorization was explored in a separate model among respondents who had consumed cannabis at least once. Individuals that had 'never' been authorized to use medical cannabis reported the lowest marketing exposure (52.1%). Self-reported marketing exposure was greater among respondents that had 'ever' been authorized (70.3% noticed; AOR=1.88; 95% CI=1.77-2.00; p<.001) or were 'currently' authorized (77.6% noticed; AOR=2.94; 95% CI=2.80-3.08; p<.001) to use medical cannabis.

Table 2. Mixed effects logistic regression for noticing cannabis advertising across policy changes (n=185,388)

	% Noticed	OR (95%CI)	P-value
Policy status of cannabis			
Illegal	35.37%	Ref	Ref
Medicalized in past 12 months	39.24%	1.16 (1.01, 1.33)	0.034
Medicalized for 1-3 years	42.87%	1.30 (1.17, 1.45)	<0.001
Medicalized for 4+ years	41.12%	1.30 (1.18, 1.45)	<0.001
Recreational legalized in past 12 months	49.96%	1.83 (1.65, 2.04)	<0.001
Recreational legalized for 1-3 years	56.21%	2.19 (1.97, 2.45)	<0.001
Recreational legalized for 4+ years	63.90%	2.66 (2.35, 3.01)	<0.001

Survey year			
2018/Wave 1	45.21%	Ref	Ref
2019/Wave 2	56.23%	1.27 (1.22, 1.33)	<0.001
2020/Wave 3	46.63%	0.91 (0.87, 0.95)	<0.001
2021/Wave 4	50.00%	1.06 (1.02, 1.17)	0.009
2022/Wave 5	54.04%	1.19 (1.14, 1.25)	<0.001
2023/Wave 6	54.29%	1.11 (1.06, 1.17)	<0.001
Age			
16-20 years	51.78%	Ref	Ref
21-30 years	60.74%	0.90 (0.86, 0.94)	<0.001
31-50 years	53.57%	0.64 (0.61, 0.67)	<0.001
51-65 years	43.98%	0.44 (0.42, 0.46)	<0.001
Frequency of use			
Never consumer	45.39%	Ref	Ref
Consumed more than 12 months ago	51.89%	1.38 (1.34, 1.41)	<0.001
Past-12-month consumer	52.75%	1.22 (1.17, 1.26)	<0.001
Monthly to weekly consumer	59.47%	1.56 (1.51, 1.61)	<0.001
Daily Consumer	59.82%	1.62 (1.57, 1.68)	<0.001
Sex at birth			
Female	48.60%	0.79 (0.77, 0.80)	<0.001
Male	55.00%	Ref	Ref
Education			
Less than high school	47.11%	Ref	Ref
High school diploma or equivalent	46.54%	1.10 (1.06, 1.15)	<0.001
Some university/college	51.78%	1.43 (1.37, 1.50)	<0.001
Bachelor’s degree or higher	56.55%	1.84 (1.76, 1.93)	<0.001
Ethnicity			
White (non-Hispanic)	50.48%	Ref	Ref
White (Hispanic)	60.85%	1.31 (1.27, 1.36)	<0.001

American Indian or Alaskan Native	61.22%	1.24 (1.14, 1.36)	<0.001
Asian	48.44%	0.80 (0.76, 0.84)	<0.001
Black or African American	51.45%	1.20 (1.16, 1.24)	<0.001
Native Hawaiian or Pacific Islander	54.48%	1.26 (1.10, 1.44)	0.001
Other/2+ races	57.45%	1.17 (1.11, 1.23)	<0.001
Unstated	47.93%	0.86 (0.80, 0.94)	<0.001
Income adequacy			
Difficult or very difficult	52.44%	Ref	Ref
Neither easy nor difficult	50.11%	0.89 (0.87, 0.91)	<0.001
Easy or very easy	54.71%	1.02 (0.99, 1.05)	0.125
Not Stated	31.78%	0.38 (0.36, 0.41)	<0.001
Variance of random intercept			
τ^2	0.0617		
VPC or ICC[a]	0.0184		

[a]VPC variance partition coefficient, ICC intraclass correlation coefficient

In the adjusted model, effects for sociodemographic covariates sex at birth, age, education, ethnicity, and income adequacy were also significant. Respondents that were female-at-birth reported lower marketing exposure relative to males-at-birth (48.6% vs. 55.0% noticed: AOR=0.79; 95% CI=0.77-0.80; p<.001). After adjusting for covariates, the youngest age group was associated with the greatest noticing of cannabis marketing (16-20 years; 51.8% noticed) and noticing 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% noticed), cannabis marketing exposure in adjusted models was lowest among respondents that self-identified as Asian and unstated ethnicities (48.4% and 47.9% noticed, 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).

4.2.2 Policy status and age interactions

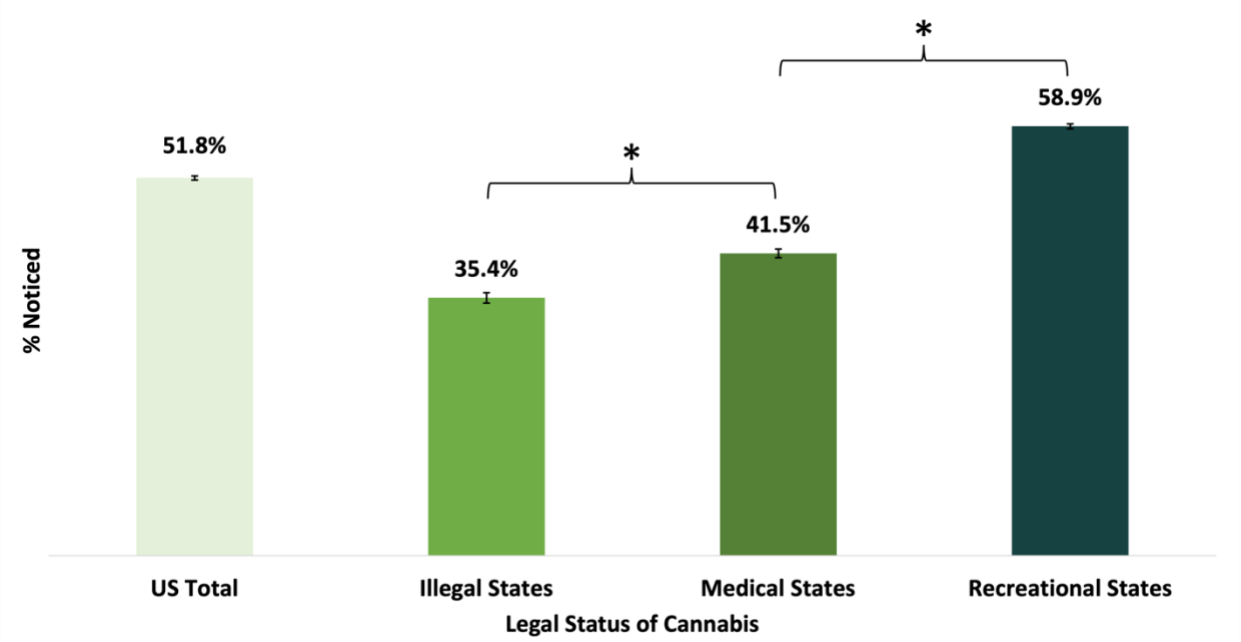
Interactions between policy change and age were examined. In all policy contexts, marketing exposure decreased with age and was lowest among respondents aged 50-65 (p≤.020 for all

contrasts). Levels of noticing were similar among ages 16-20 and 21-30 in states with illegal and medical cannabis, and in the first year following recreational legalization; however, exposure among underaged respondents was higher than all other age groups where recreational cannabis had been legal for more than one year (p≤.004). Across policy transitions, exposure among respondents aged 16-20 was similar as states moved from illegal to medical policies, with slight increases in the first three years following medical legalization (38.2% vs. 42.4% noticed: p=0.035). In states where medical cannabis was legal for four years or more, underaged respondents reported relative increases in marketing exposure (44.3% vs. 42.4% noticed 1-3 years post-medical legalization: p=0.014). This trend continued with another relative increase among underaged respondents the year of recreational legalization (51.9% noticed: p<.001), and additional increases in the 1-3 years, and 4 years after the policy change (59.5% and 64.7% noticed, respectively: p≤.003 for all contrasts).

4.2.3 Sensitivity Analyses

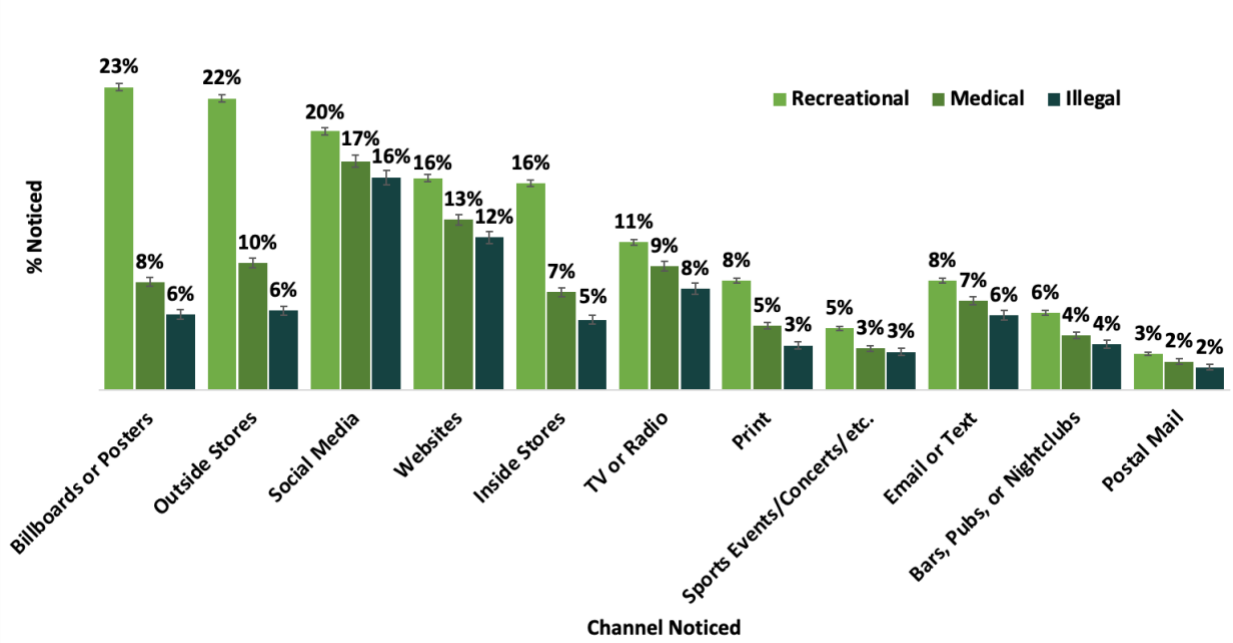
A sensitivity analysis was conducted to examine noticing using a simplified measures of policy status, in which differences were tested by cannabis laws without accounting for the time since implementation (i.e. illegal, medical, and recreational— see Table A6). Figure 2 presents point estimates for marketing exposure overall across states and in illegal, medical, and recreational states. Noticing cannabis marketing was higher in medical states than illegal states (41.5% vs. 35.4% noticed: AOR=1.25; 95% CI=1.13-1.38; p<0.001), and noticing was higher in recreational states compared to medical states (58.9% vs. 41.5%; AOR=1.49; 95% CI=1.42-1.56; p<.001). Unadjusted point estimates for noticing by channel are presented in Figure 3. Self-reported exposure is greatest via billboards and outside stores in recreational states (23.2% and 22.3%, respectively); however, exposure is highest via virtual channels social media and websites in medical and illegal states (17.4% and 13.0%, respectively).

Figure 2. Noticing cannabis ads across legal statuses



Note. Asterisks indicate the level of statistical significance, where *=p≤0.05.

Figure 3. Noticing cannabis ads across legal statuses by channel



4.3 Marketing exposure within states with legal cannabis sales

4.3.1 Main effects

The following analyses were conducted with data from a subset of recreational states where legal cannabis retailers were operational (i.e. 'legal sales states').

Table 3 presents regression results for self-reported cannabis marketing exposure in states with legal recreational cannabis sales (point estimates for self-reported exposure by state are presented in Table A7). The variance partition coefficient indicates the random intercept of state accounts for just over 1% of the variability in noticing. States with a marketing restriction strength of Level 1 and Level 2 reported similar levels of cannabis marketing exposure (61.4% and 61.8%, respectively—see Figure 4). States with legal cannabis sales that have a restriction strength of 'Level 3' or 'high restriction' reported the lowest cannabis marketing exposure relative to states at a 'Level 2' (53.4% noticed: AOR=0.77; 95% CI=0.60-0.90; p=0.067). Noticing also differed by time since legal sales began. Cannabis marketing exposure increased in the 1-3 years following the start of legal sales, relative to the first year legal retailers were introduced (60.9% vs. 53.1% noticed: AOR=1.34; 95% CI=1.28-1.40; p<.001). Following this initial increase 1-3 years after the start of legal sales, self-reported noticing decreased slightly after four or more years in a legal market in the final adjusted model (64.6% noticed: AOR=0.87; 95% CI=0.83-0.91; p<.001).

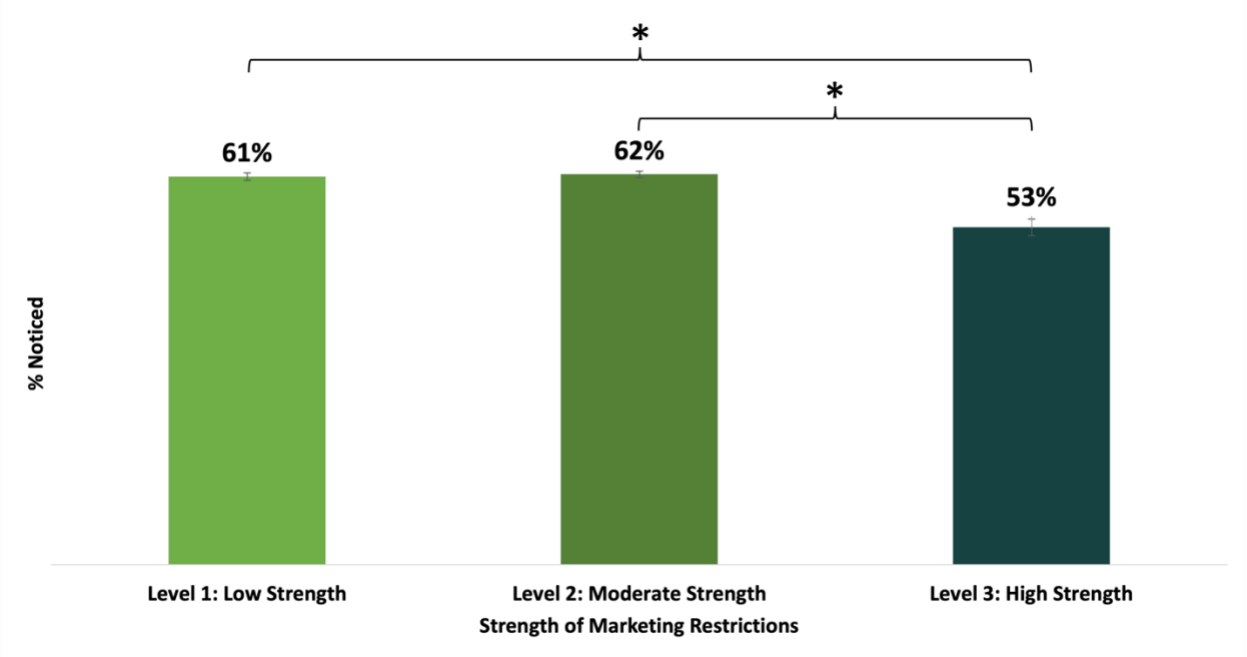
Table 3. Mixed effects logistic regression for noticing cannabis advertising within legal sales states (n=99,132)

	% Noticed	OR (95%CI)	P-value
Strength of Marketing Restrictions			
Level 1 (Low strength: Score 11-33)	61.41%	Ref	Ref
Level 2 (Moderate strength: Score 34-39)	61.77%	1.03 (0.82, 1.29)	0.789
Level 3 (High strength: Score 40-55)	53.39%	0.79 (0.62, 1.02)	0.067
Time since legal sales began			
<1 Year	53.08%	Ref	Ref
1-3 Years	60.88%	1.34 (1.28, 1.40)	<0.001
4+ Years	64.56%	1.16 (1.09, 1.24)	<0.001
Age			
16-20 years	62.96%	Ref	Ref
21-30 years	66.85%	0.85 (0.80, 0.91)	<0.001
31-50 years	61.82%	0.62 (0.59, 0.66)	<0.001
51-65 years	55.33%	0.48 (0.45, 0.51)	<0.001
Frequency of use			
Never consumer	56.28%	Ref	Ref
Consumed more than 12 months ago	62.40%	1.37 (1.32, 1.41)	<0.001
Past-12-month consumer	59.66%	1.12 (1.07, 1.17)	<0.001
Monthly to weekly consumer	64.43%	1.34 (1.29, 1.40)	<0.001
Daily Consumer	65.25%	1.47 (1.41, 1.53)	<0.001
Sex at birth			
Female	58.37%	0.81 (0.79, 0.83)	<0.001
Male	63.57%	Ref	Ref
Education			
Less than high school	58.44%	Ref	Ref
High school diploma or equivalent	55.77%	1.06 (0.99, 1.13)	0.082
Some university/college	61.37%	1.43 (1.34, 1.52)	<0.001

Bachelor's degree or higher	64.20%	1.75 (1.64, 1.87)	<0.001
Ethnicity			
White (non-Hispanic)	60.62%	Ref	Ref
White (Hispanic)	65.79%	1.19 (1.13, 1.24)	<0.001
American Indian or Alaskan Native	63.57%	1.08 (0.97, 1.20)	0.176
Asian	54.55%	0.74 (0.69, 0.78)	<0.001
Black or African American	59.78%	1.04 (0.99, 1.09)	0.121
Native Hawaiian or Pacific Islander	66.40%	1.16 (0.95, 1.42)	0.146
Other/2+ races	65.93%	1.16 (1.08, 1.24)	<0.001
Unstated	55.23%	0.88 (0.80, 0.97)	0.012
Income adequacy			
Difficult or very difficult	61.63%	Ref	Ref
Neither easy nor difficult	59.32%	0.90 (0.87, 0.93)	<0.001
Easy or very easy	64.13%	1.04 (1.01, 1.08)	0.014
Not Stated	38.38%	0.38 (0.35, 0.41)	<0.001
Variance of random intercept			
τ^2	0.0439		
VPC or ICC[a]	0.0132		

[a]VPC variance partition coefficient, ICC intraclass correlation coefficient

Figure 4. Noticing cannabis ads across restriction strengths within legal sales states



Note. Asterisks indicate the level of statistical significance, where *=p≤0.05.

Frequency of cannabis use was also associated with different levels of noticing cannabis marketing in states with legal sales. Daily consumers reported the greatest past-year marketing exposure relative to never consumers, who reported the lowest (65.3% vs. 56.3% noticed: AOR=1.47; 95% CI=1.41-1.53; p<.001). In a separate model of only respondents that had consumed cannabis at least once, individuals that were currently authorized to use medical cannabis reported greater noticing than people that had never been authorized to use medical cannabis (79.4% vs. 60.8% noticed: AOR=2.39; 95% CI=2.24-2.56; p<.001).

Covariates age, sex at birth, education, ethnicity, and income adequacy were independently associated with differences in marketing exposure. In the final adjusted model, the youngest age group with respondents aged 16-20 was associated with the greatest marketing exposure (63.0% noticed). Noticing decreased with age and was lowest among respondents aged 51-65 years (55.3%: AOR=0.48; 95% CI=0.45-0.51; p=<.001). Respondents that self-identified as female-at-birth were less likely to report cannabis marketing exposure than males-at-birth (58.4% vs. 63.6% noticed: AOR=0.81; 95% CI=0.79-0.83; p=<.001). Respondents that had less than a high school education (58.4%), or a high school diploma (55.8%) reported similar levels of marketing exposure, whereas respondents with a Bachelor's degree or more reported the highest marketing exposure (64.2% noticed: AOR=1.75; 95% CI=1.64-1.87; p<.001). Being of Asian ethnicity was associated with the lowest levels of noticing relative to non-Hispanic Whites (54.6% vs. 60.6% noticed: AOR=0.74; 95% CI=0.69-0.78; p=<.001), and marketing exposure was highest among respondents that identified as Hispanic White (65.8%: AOR=1.19; 95% CI=1.13-1.24; p<.001), and 'Other' or two or more races (65.9%; AOR=1.16; 95% CI=1.08-1.24; p<.001 for all contrasts). Cannabis marketing exposure was highest among respondents that reported it was 'easy or very easy' to make ends meet (64.1% noticed: AOR=1.04; 95% CI=1.01-1.08;

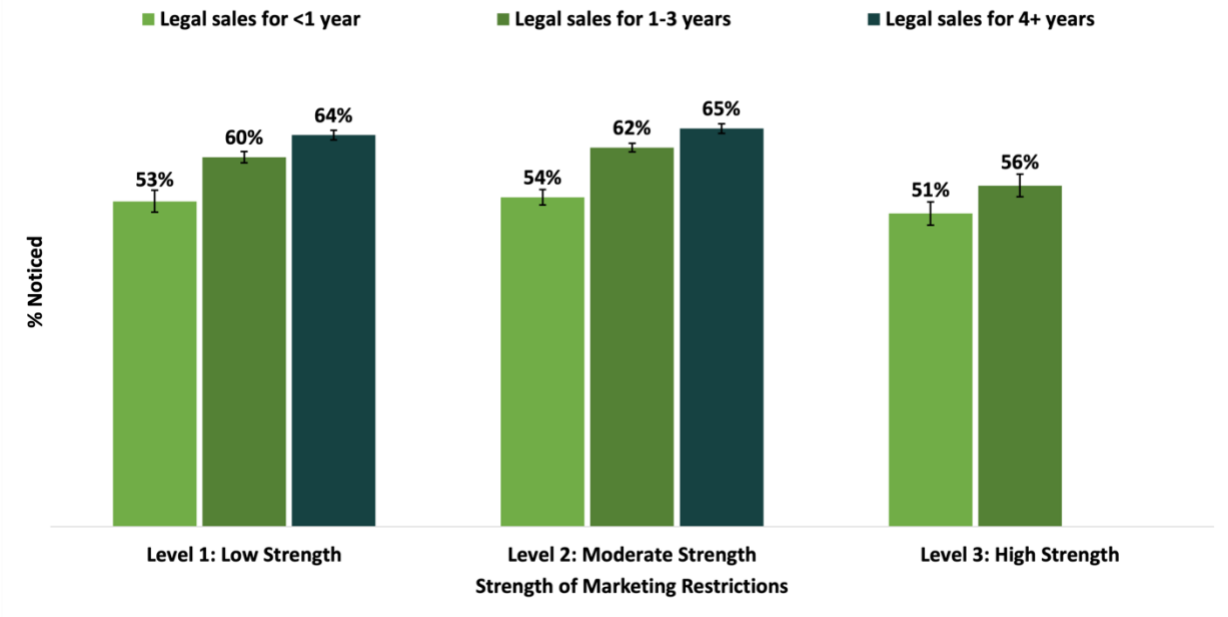
p=0.014), and respondents with unstated income adequacy reported the lowest cannabis marketing exposure relative to those that reported it was 'difficult or very difficult' to make ends meet (38.4% vs. 61.6%: AOR=0.38; 95% CI=0.35-0.41; p<.001).

4.3.2 Sensitivity Analyses

4.3.2.1 Restriction strength and time interactions

Interactions between restriction strength and time in states with legal sales could not be explored in an adjusted model due to insufficient data (no states had Level 3 restrictions for a period of 4+ years). However, unadjusted point estimates for noticing over time by restriction strength are presented in Figure 5. While exposure increases over time since legal sales began in all restriction levels, the initial increase in the first 1-3 years of legal sales may be less dramatic in states with high strength restrictions.

Figure 5. Noticing by Strength of Marketing Restrictions in States with Legal Sales



4.3.2.2 Noticing Index within states with legal sales

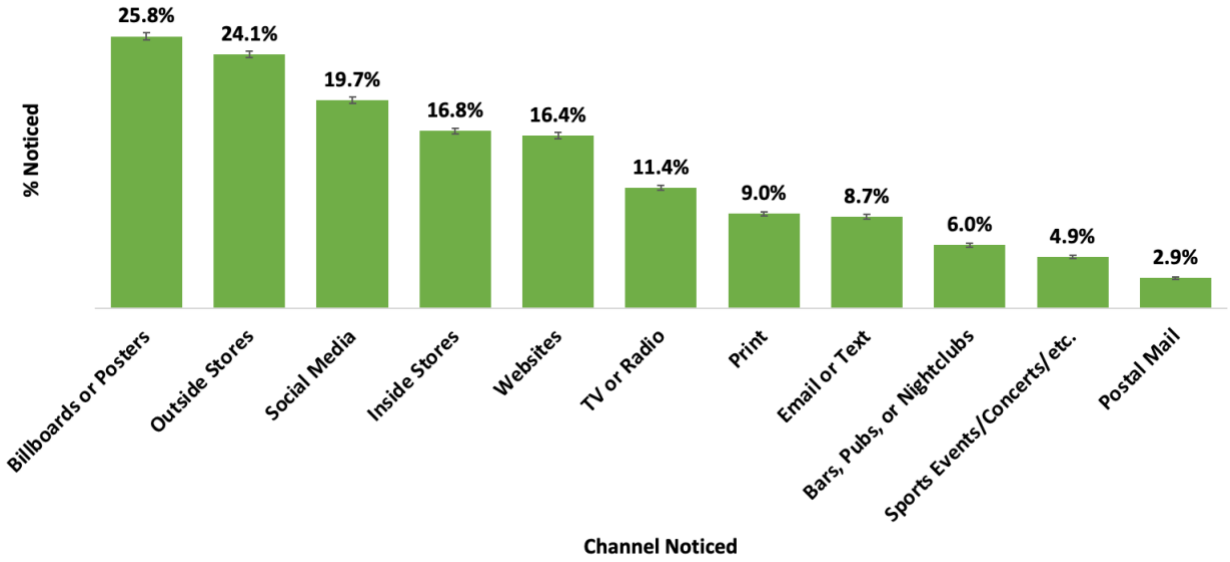
Table A8 presents a sensitivity analysis of Noticing *Index*. Noticing *Index* represents the mean number of channels where cannabis marketing was noticed in the past 12 months, on a scale of 0 to 11. Relative to the year legal sales began (Mean=1.16), mean channels noticed increased one to three years following the start of legal sales, and again four or more years after the start of legal sales (Mean=1.45: ß=0.24; 95% CI=0.21-0.28; p<.001 and Mean=1.59: ß=0.34; 95% CI=0.30-0.38; p<.001, respectively). States with a restriction strength of Level 1 and Level 2 reported a similar mean number of channels noticed (Mean=1.51 and 1.45, respectively). States with Level 3 restrictions reported the lowest mean number of channels noticed relative to states with Level 2 restrictions (Mean=1.17: ß=-0.14; 95% CI=-0.09,-0.19; p<.001. Being underaged was associated with noticing more channels in the adjusted linear model (Mean=1.56), relative to all other age groups (p≤.001 for all contrasts).

4.3.3 Main effects by channel

4.3.3.1 Noticing by channel within states with legal sales

Figure 6 presents the presents average self-reported exposure in states with legal sales for each of the eleven channels included in the study. In states with legal sales, overall noticing was greatest via billboards or posters (25.8% noticed), followed by outside stores (24.1%) and social media (19.7%). Fewer than 10% of respondents reported noticing cannabis ads via print, email or text, bars, sports or events, or postal mail.

Figure 6. Noticing cannabis marketing by channel in states with legal sales



4.3.3.1.1 Noticing cannabis marketing via postal mail

Noticing cannabis marketing via postal mail did not differ by channel restriction strength (see Table A9). Legal sales for 4 or more years are associated with a modest increase in noticing relative to the first year of legal sales in the adjusted model (2.9% vs. 2.7% noticed: AOR=1.18; 95% CI=1.01-1.39; p=0.043); however, this increase does not correspond to meaningful differences in population-level noticing. Rates of noticing were low across all sample groups; however, being aged 51-65 was associated with less exposure via postal mail relative to being underaged in the final adjusted model (1.8% vs. 2.5% noticed among respondents aged 16-20: AOR=0.58; 95% CI=0.48-0.70; p<.001). A summary of channel findings is presented in Figures 7-9.

4.3.3.1.2 Noticing cannabis marketing via websites

There was no effect of channel marketing restriction strength for exposure via websites (see Table A10). Figure 7 presents AORs for noticing cannabis marketing by age group, across the five most noticed channels. Noticing was similar in the 1-3 years following the start of legal sales relative to the year sales began (17.0% and 15.3%, respectively); however, noticing decreased after 4 or more years of legal sales after adjusting for covariates (16.2%: AOR=0.81; 95%

CI=0.76-0.86; p<.001). Being underaged (19.4% noticed) was associated with greater marketing exposure via websites than any other age group in the final adjusted model (p<.001 for all contrasts).

4.3.3.1.3 Noticing cannabis marketing via email or texts

Table A11 presents regression results for noticing via email or texts. Self-reported noticing via emails or texts did not differ by the strength of channel restrictions or time since legal sales began. Respondents aged 21-30 reported the greatest exposure to cannabis marketing via email or texts relative to ages 16-20 (10.7% vs. 7.1% noticed: AOR=1.16; 95% CI=1.05-1.29; p=0.006), with the lowest exposure reported among ages 51-65 (7.1%: AOR=0.84; 95% CI=0.75-0.94; p=0.002).

4.3.3.1.4 Noticing cannabis marketing in bars, pubs, and nightclubs

The results of the analysis for noticing in bars, pubs, and nightclubs is presented in Table A12. Strength of restrictions for marketing in bars, pubs, or nightclubs was not associated with differences in marketing exposure. Noticing cannabis marketing in bars, pubs, or nightclubs increased one to three years after the start of legal sales relative to the first year that sales began (5.8% vs. 5.1% noticed: AOR=1.21; 95% CI=1.20-1.34; p<.001); however, exposure was stable four or more years after the start of legal sales. Respondents aged 21-30 reported the greatest exposure to cannabis marketing via bars, pubs, and nightclubs relative to underaged respondents (9.6% vs. 6.0% noticed: AOR=1.13; 95% CI=1.01-1.27; p=0.033), whereas exposure was lowest among respondents over 30 (p<.001 for all contrasts).

4.3.3.1.5 Noticing cannabis marketing inside stores that sell marijuana

Regression results for noticing cannabis marketing inside cannabis retailers is presented in Table A13. Noticing was similar across all restriction strength groups. However, noticing cannabis marketing inside of cannabis retailers increased following the start of legal sales, with greater noticing after one to three years of retailers opening (12.1% vs. 15.4% noticed: AOR=1.36; 95% CI=1.27-1.45; p<.001). Noticing marketing inside stores was higher among respondents aged 21-30 than 16-20 (21.7% vs. 13.8% noticed: AOR=1.13; 95% CI=1.05-1.23; p=0.002), however the youngest age group reported greater noticing inside stores than respondents 30 or older (p<.001 for all contrasts: see Figure 7).

4.3.3.1.6 Noticing outside stores that sell cannabis

Table A14 presents regression results for noticing outside stores that sell cannabis. Noticing was similar across channel restriction strengths. Exposure to marketing outside cannabis retailers increased in the one to three years after the start of legal sales (21.9% vs. 16.5% in the first year: AOR=1.51; 95% CI=1.43-1.60; p<.001). After adjusting, this initial increase was followed by a relative decrease in noticing 4 or more years after legal sales began (29.7%: AOR=0.91; 95% CI=0.86-0.96; p=0.001). Underaged respondents aged 16-20 reported the greatest exposure to marketing outside stores (27.2%), relative to all other age groups (p<.001 for all contrasts presented in Figure 7).

4.3.3.1.7 Noticing at sports games and events

Regression results for noticing cannabis marketing at sports games and events are presented in Table A15. High-strength channel restrictions were associated with lower marketing exposure relative to low-strength restrictions (4.2% vs. 4.9% noticed: AOR=0.74; 95% CI=0.57-0.96; p=0.023; see Figure 9); however, differences in population-level exposure estimates were negligible. Cannabis marketing exposure at sports games and events increased initially following the start of legal sales (5.1% vs. 4.0% noticed: AOR=1.31; 95% CI=1.18-1.44; p<.001) but was relatively stable after the first one to three years. Exposure was greatest among respondents aged 16-20 (6.1% noticed) relative to all other age groups (p≤.042 for all contrasts).

4.3.3.1.8 Noticing via TV or radio

Table A16 presents regression results for noticing via TV or radio. Strength of channel restrictions for marketing via TV or radio broadcasts was not associated with differences in marketing exposure. However, noticing decreased after 4 or more years of legal sales (11.1% vs. 10.9% noticed the year sales began: AOR=0.71; 95% CI=0.65-0.78; p<.001). Underaged respondents aged 16-20 (12.6% noticed) reported higher exposure than respondents over 50 (8.2%: AOR=1.67; 95% CI=1.54-1.85; p<.001) but noticing among other age groups was similar.

4.3.3.1.9 Noticing via billboards or posters

Table A17 presents regression results for noticing cannabis ads via billboards or posters. Noticing cannabis marketing was lowest in states with high strength channel restrictions relative to low strength (11.2% vs. 20.8% noticed: AOR=0.42; 95% CI=0.26-0.68; p<.001). Noticing via billboards and posters increased in the one to three years following the start of legal sales (27.3% vs. 16.1% noticed: AOR=1.72; 95% CI=1.63-1.82; p<.001) followed by a relative decrease after 4 or more years (28.4%: AOR; 1.43; 95% CI=1.33-1.54; p<.001). After adjusting, respondents aged 16-20 reported greater exposure to cannabis marketing via billboards (26.2%) than any other age group (<.001 for all contrasts; see Figure 7).

4.3.3.1.10 Noticing via print publications

Strength of channel restrictions was not associated with differences in marketing exposure via print publications (see Table A18). Self-reported exposure to print ads decreased one to three years following the start of legal sales after adjusting (8.4% vs. 6.6%: AOR=0.89; 95% CI=0.81-0.96; p=0.004) and was slightly greater among underaged respondents relative to respondents aged 21-30 (7.2% vs. 8.0% noticed: AOR=1.14; 95% CI=1.02-1.27; p=0.019).

4.3.3.1.11 Noticing via social media

Regression results for noticing via social media are presented in Table A19. Marketing exposure did not differ by channel restriction strength. Noticing was similar in the first three years following the start of legal sales; however, exposure decreased after four years relative to the year legal sales began (19.0% vs. 19.5% noticed: AOR=0.84; 95% CI=0.79-0.90; p<.001). The youngest respondents aged 16-20 (28.1% noticed) reported greater marketing exposure via social media than any other age group (p<.001 for all contrasts; see Figure 7)

Figure 7. Adjusted odds ratios for noticing cannabis ads within most noticed channels by age

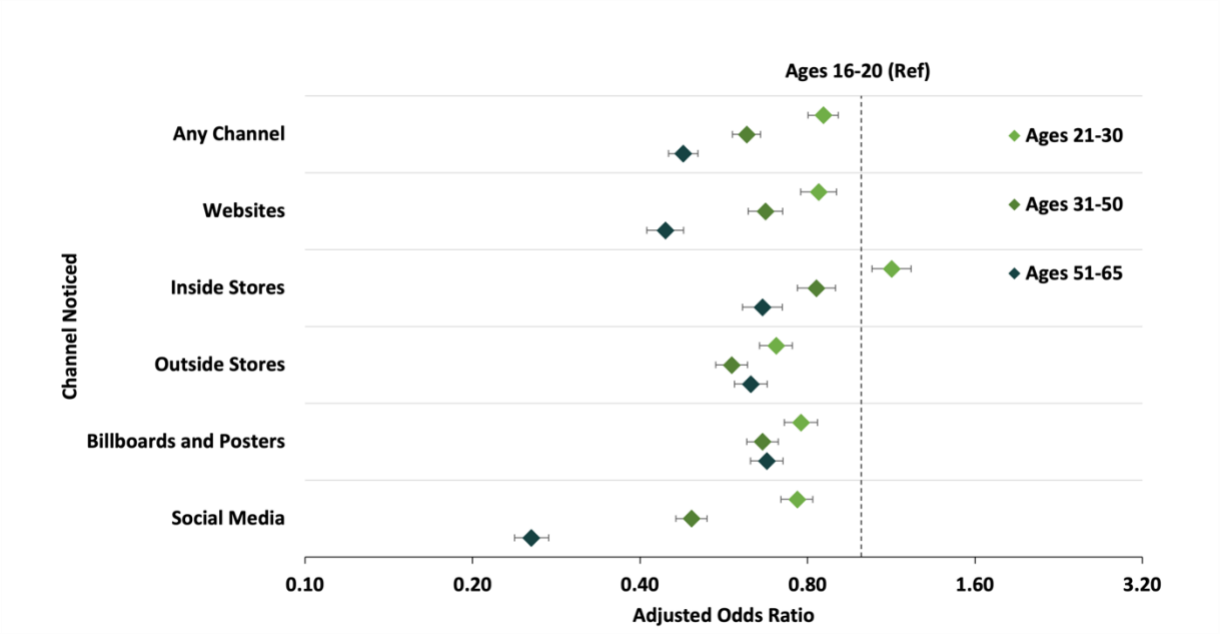


Figure 8. Adjusted odds ratios for noticing cannabis ads by time since legal sales began

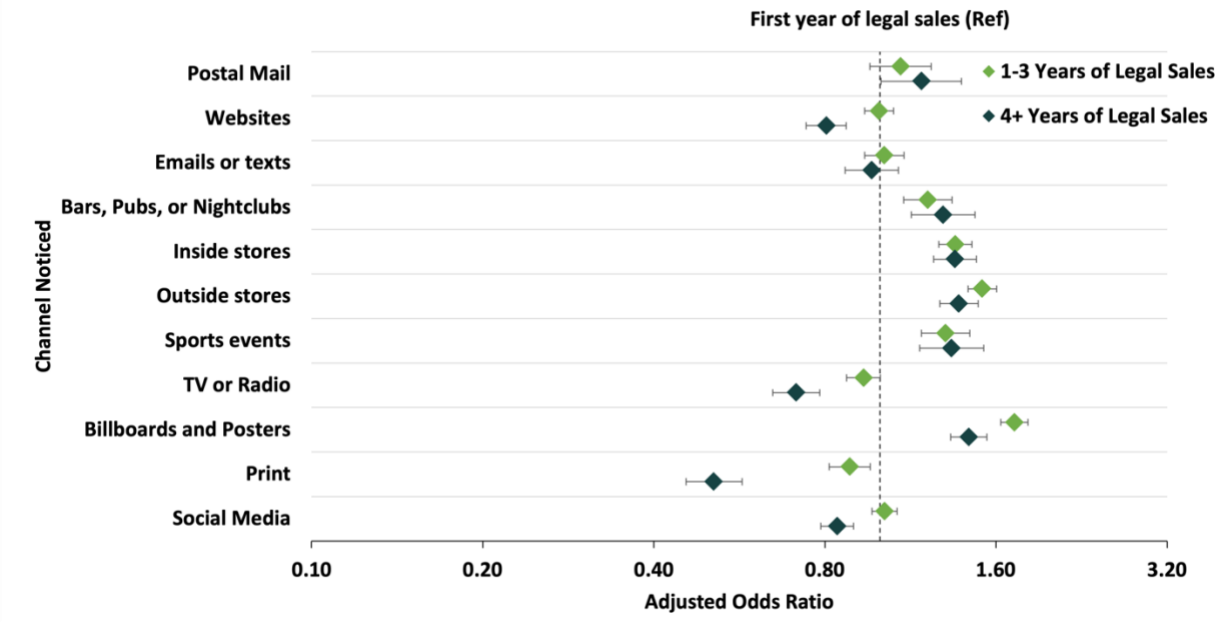
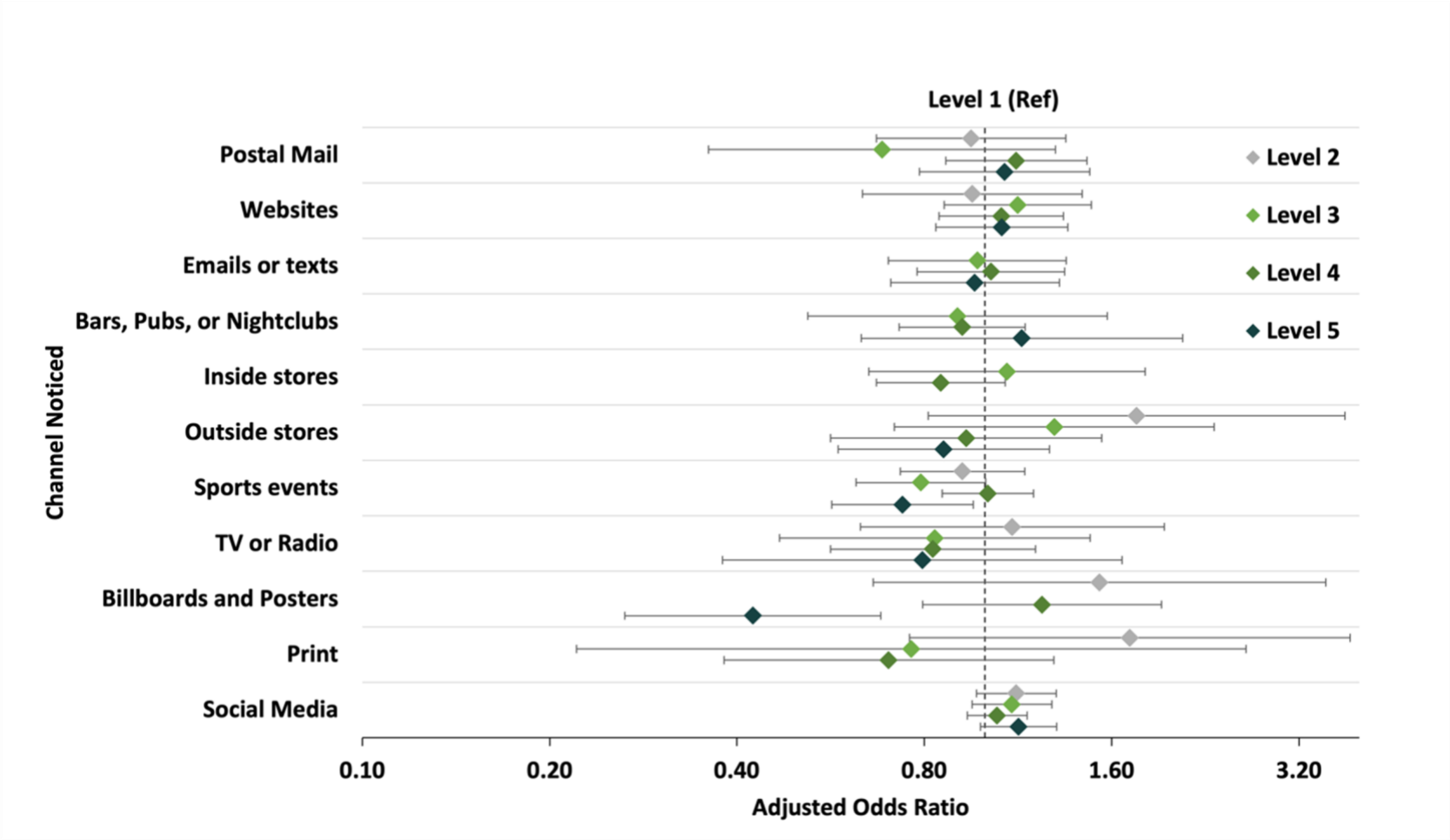


Figure 9. Adjusted odds ratios for noticing cannabis marketing by channel restriction level



5.0 DISCUSSION

Currently, there is little research examining the impacts of cannabis policies on marketing exposure; however, there is a growing body of literature suggesting marketing exposure and cannabis consumption are closely associated.[9–11] The current study adds to the literature by demonstrating substantial increases in exposure to cannabis marketing with the introduction of medical and recreational cannabis laws. The current study is also one of the first to examine different levels of marketing restrictions in states that have legal cannabis markets. These findings are discussed in the following sections.

5.1 Marketing exposure and cannabis laws

The current study is among the first to examine trends in marketing exposure pre- and post-cannabis legalization in the US. As hypothesized, the most dramatic increases in marketing exposure occurred in the years following recreational legalization. Noticing in established recreational markets is nearly double that in illegal markets. These findings align with previous research indicating much higher exposure in recreational states relative to medical and illegal states.[11,33] An important finding from this study is the immediacy of the increase in cannabis marketing exposure following policy implementation. Within the first 12 months post-legalization, noticing was already markedly higher than in states with established medical markets. This highlights the importance of implementing policies to prevent this exposure with or even prior to legalization, as markets may already be mobilizing at this time.

Higher levels of noticing cannabis marketing were also observed in medical cannabis markets, relative to illegal jurisdictions. Many medical states permit some form of cannabis marketing[31], and reported exposure in exclusively medical states was higher than in fully illegal states. Research assessing population-level marketing exposure in medical markets is limited; however, our findings align with increases observed among California youth prior to recreational legalization.[43] These findings, alongside evidence suggesting adolescent exposure to medical cannabis marketing is strongly associated with increases in use and intentions to use, highlight the importance of implementing policies to reduce marketing exposure, even in exclusively medical markets.[32,43] It is also important to note that medical markets in the US vary widely in terms what marketing activities are permitted. Future research should explore how much of this exposure is related to regulated medical cannabis vs. illegal markets.

5.2 Marketing restrictions and overall marketing exposure in states with legal sales

To our knowledge, this is the first study to examine the association between cannabis marketing exposure and the strength or comprehensiveness of marketing restrictions in the US. There was evidence that comprehensive restrictions reduce overall exposure to cannabis marketing, but this reduction was only observed in states with the highest level of restriction. This is consistent with previous literature on tobacco marketing for which partial marketing restrictions are relatively ineffective at preventing marketing exposure.[7] In interpreting these findings, it should be noted that very few states had implemented comprehensive marketing restrictions compared to other jurisdictions that have legalized cannabis, including Canada, Uruguay, and Germany.[31] Even in states such as Montana, with relatively comprehensive advertising

restrictions, these restrictions did not apply to marketing of cannabis brands or companies where no specific products are advertised.[44] This is in contrast to Canada, where prohibitions for cannabis promotions include promotion of brand elements.[45] Additionally, it is important to consider the novelty of legal cannabis sales in many US states when interpreting these findings. No longer term data were available for restriction levels 1 and 4 due to the recency of cannabis legalization. Future studies should continue to monitor long-term impacts of these regulations.

5.3 Exposure via individual channels in states with legal sales

The findings suggest that marketing exposure is greatest in channels: billboards, digital sources (social media and websites), and inside and outside retail stores. It was hypothesized that self-reported cannabis marketing exposure via individual channels would be higher in states with fewer channel restrictions. While it is not clear whether overall strength of marketing restrictions effectively reduce cannabis marketing exposure, there were two channels where comprehensive restrictions were associated with significant reductions in marketing exposure: billboard or poster advertising, and advertising through event sponsorships. Notably, these are both 'physical' marketing channels that may be easier to regulate and enforce. Previous research in the US and Canada has indicated noncompliance with marketing regulations may be particularly rampant among virtual channels such as social media or websites.[46–48] For virtual channels in particular, regulatory 'spillover effects' may render stronger restrictions less effective if neighbouring states lack stringent regulations. Relatively similar levels of self-reported exposure via social media were observed across legal statuses, which would further support this possibility. While stronger restrictions were not associated with reductions in exposure in many channels, it is important to note data for some restriction levels were limited in some channels, sometimes resulting in only 3 or 4 channels for analysis. Findings from the current study suggest that comprehensive marketing restrictions for physical channels such as billboards and event sponsorships can be effective in reducing population-level exposure; however, it is not clear whether high exposure from other channels is the result of ineffective regulatory strategies or lack of enforcement. Future studies should incorporate compliance to restrictions where possible.

It is important to note that cannabis or 'marijuana' is still classified as a Schedule I drug in the United States, which may have implications for advertising even in states with legal sales. For example, while many states with legal sales have provisions permitting some advertising via print, federal law currently prohibits any advertising of a Schedule I substance in newspapers, magazines, handbills, or other publications.[49] The current study found noticing cannabis marketing in print was similar regardless of channel restrictions in states with legal sales, which could be due in part to feasibility issues and potentially strict repercussions if marketing crosses state lines. As a Schedule I drug, federal law currently considers cannabis to have no medical use and a "high potential for abuse", comparable in severity to heroin and LSD.[50] Notably, several recent reports have suggested the classification of cannabis may change from Schedule I to Schedule III[51], in which case marketing trends for cannabis may also be subject to change. It is important that future research monitors trends in marketing exposure over time as the legal landscape continues to change.

5.4 Sociodemographic factors associated with greater cannabis marketing exposure

Exposure also differed by sociodemographic factors such as age, ethnicity, and sex at birth. Notably, being underaged was associated with the greatest overall exposure to cannabis marketing after adjusting for covariates, contrary to study hypotheses. Ages 16-20 reported greater exposure than any other age group for cannabis marketing via websites, outside cannabis stores, event sponsorships, billboards and posters, and social media. Within the five channels where respondents reported the greatest overall noticing in legal states, exposure was highest among the youngest age group for all but exposure inside cannabis stores, where their entry is generally prohibited. These results align with earlier findings published from the ICPS study[11], and are concerning from a public health standpoint given what is known about marketing exposure and smoking initiation among youth.[2,7] These findings indicate current marketing restrictions are not sufficient in protecting underaged people from marketing exposure and inducements to use, despite many regulations including audience composition requirements to reduce underage exposure.[31] As previously discussed, it is critical that marketing regulations are comprehensive, as restrictions that are not comprehensive are much less effective in preventing marketing exposure and tend to redirect advertisers towards alternative media/locations rather than reducing marketing.[7]

The current study found noticing differed by race. Respondents that self-identified as Asian consistently reported the lowest exposure to cannabis ads across legal contexts. This aligns with data suggesting cannabis use and social norms for cannabis are lower among persons of Asian ethnicity.[52,53] However, people of colour generally reported noticing the most cannabis ads at the national level compared to white respondents. Notably, this disparity was observed to a lesser extent in legal markets, where only Hispanic respondents and people who identified as "2+ races or other" reported greater noticing than white respondents. While models controlled for frequency of cannabis use, racial differences in noticing correspond with trends observed for cannabis use frequency.[54] Historically, drug policies and cannabis policies have been used to disproportionately target people of colour[55], and it is important to consider racial differences in cannabis policy outcomes. Additionally, some evidence suggests communities with a larger proportion of racial and ethnic minority groups are more likely to have cannabis retailers[56], which may be an important consideration when examining marketing exposure. However, more research is needed to fully understand the reasons for these disparities in advertising exposure.

Overall marketing exposure via at least one channel was also greater among males-at-birth, as hypothesized; however, females-at-birth did report greater exposure than males-at-birth for exposure via billboards/posters, social media, and inside and outside cannabis retailers. This is similar to findings reported by Kreuger et al[37], where women were more likely to report exposure to online advertising; however, in the current study this also observed for marketing on TV. The channels where females-at-birth reported greater exposure relative to males-at-birth were also where all respondents reported the greatest noticing overall, which would suggest males-at-birth may—on average—be exposed to more marketing channels than females-at-birth. This also aligns with findings from a sensitivity analysis of noticing *Index*, where the *Index* of mean marketing channels noticed was greater for males-at-birth.

5.5 Limitations

The proposed study has several limitations that warrant consideration. ICPS data are collected via self-reported surveys, and therefore social desirability bias is a concern. However, surveys are self-administered online, and data is anonymized. At the end of the survey, respondents are also asked whether they were able to answer questions truthfully, and respondents that respond "no" are removed from the final sample. Additionally, ICPS data uses nonprobability-based sampling which may not be representative of true population estimates. To mitigate this risk, data are weighted similar 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 small samples and region refers to the nine US Census Divisions.[42]

Given the use of self-reported survey measures to measure cannabis marketing exposure, recall bias may be a concern. Respondents may not accurately recall the number or type of cannabis marketing channels to which they were exposed, and younger people may also be more likely to recall advertisements than other age groups.[57] Thus, self-reported exposure is unlikely to be an unbiased measure of actual marketing at the individual level. However, previous research on tobacco advertising and anti-drug campaign advertisements has demonstrated a high degree of correlation between self-reported measures of marketing exposure and objective measures of marketing[58,59], indicating reasonable validity for self-reported marketing exposure.

There were also data limitations encountered during the analysis of this study. Due to the relative novelty of legal sales in many US states, there were not sufficient time points for states with a restriction strength of Level 3 to adequately assess interactions between restriction strength and time. Additionally, some channels were missing data for one or more channel restriction levels, which presented challenges for analysing associations between restriction strength and noticing within these channels. Unadjusted point estimates for marketing exposure over time for each restriction group are provided, but future research should continue to monitor trends in marketing exposure and analyze differences in these trends between restriction levels.

There are also limitations associated with the coding and scoring of marketing restrictions based on state-level regulations. First, although comprehensive efforts were made to access, identify, and verify regulations, it is possible that some information was omitted. Second, there is variability across states in how 'advertising' is defined and the types of marketing activities included in the restrictions. For example, some states define advertising as only promotion of a 'cannabis product' with exemptions for marketing only a 'brand', whereas others are more comprehensive and apply to any promotion of cannabis or cannabis-related brands and services. These distinctions are challenging to represent in any 'coding' or index. In other cases, regulatory documents were vague and lacked important details to determine important areas of scope. While efforts were made to contact regulatory agencies to clarify these issues for each of the 20 states with legal sales, only half responded to confirm coding, and in several cases, representatives were unable to provide details or cited legal issues for not responding. Third, some marketing channels and activities may have a greater relative impact on marketing exposure than others, whereas the index created for the current study 'weighted' each

marketing channel equally. Finally, the index did not account for whether participants lived in counties or municipalities that have 'opted out' of legal retail stores. This would likely decrease marketing exposure within these jurisdictions, regardless of state-level marketing regulations. However, the distribution of 'op-out' counties across state restriction groups was examined and were evenly dispersed across restriction strength categories, reducing the likelihood of significantly biasing results in any direction. Despite these challenges, the efforts to identify and categorize state-level restrictions on cannabis advertising represents the most comprehensive effort to date.

Future research should examine individual-level factors that may interact with marketing exposure in greater depth. In particular, future research should examine potential differences based on gender-identity, which may be an important factor in marketing exposure. Due to the low prevalence of people identifying as a gender-minority, we were constrained in examining gender in the full analytical models; however, descriptive statistics provided in Table A20-A21 suggest important differences that warrant further consideration.

Finally, previous research has demonstrated the relationship between noticing cannabis advertising and cannabis use is likely bidirectional. Cannabis use may precede increases in advertising exposure with cannabis consumers more likely to seek out, and be exposed to cannabis marketing; conversely, marketing exposure can increase susceptibility to use cannabis by minimizing perceived risk and enhancing positive social norms.[5,9–12] It is possible that differences in rates of cannabis use between states may confound the effects of advertising restrictions. To mitigate potential bias, cannabis use frequency was included in each final regression model, along with other sociodemographic variables.

6.0 CONCLUSION

Marketing plays an important role in promoting substance use, particularly among young people.[9,10] To date, there is little empirical evidence on marketing exposure under legal cannabis markets in the US, including potential differences between state-level regulations in jurisdictions with legal cannabis markets. The current study indicates that both 'medical' and 'recreational' cannabis legalization increases exposure to cannabis marketing. In addition, comprehensive marketing restrictions may reduce exposure in states with legal recreational cannabis markets. Finally, although protecting young people from cannabis promotions is a primary policy objective for virtually all states with legal cannabis markets, the findings highlight high levels of cannabis marketing exposure among young people, including youth below the minimum legal age.[1,3,4] Future research should monitor these trends and the effectiveness of advertising regulations in legal markets to inform future policy decisions.

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APPENDIX

Table A1. State-level legal status by survey wave

	Wave 1 (2018)	Wave 2 (2019)	Wave 3 (2020)	Wave 4 (2021)	Wave 5 (2022)	Wave 6 (2023)
Georgia	Illegal*	Illegal*	Illegal*	Illegal*	Illegal*	Illegal*
Idaho	Illegal	Illegal	Illegal	Illegal	Illegal	Illegal
Indiana	Illegal*	Illegal*	Illegal*	Illegal*	Illegal*	Illegal*
Iowa	Illegal*	Illegal*	Illegal*	Illegal*	Illegal*	Illegal*
Kansas	Illegal*	Illegal*	Illegal*	Illegal*	Illegal*	Illegal*
Kentucky	Illegal*	Illegal*	Illegal*	Illegal*	Illegal*	Illegal*
Nebraska	Illegal	Illegal	Illegal	Illegal	Illegal	Illegal
North Carolina	Illegal*	Illegal*	Illegal*	Illegal*	Illegal*	Illegal*
South Carolina	Illegal*	Illegal*	Illegal*	Illegal*	Illegal*	Illegal*
Tennessee	Illegal*	Illegal*	Illegal*	Illegal*	Illegal*	Illegal*
Texas	Illegal*	Illegal*	Illegal*	Illegal*	Illegal*	Illegal*
Wisconsin	Illegal*	Illegal*	Illegal*	Illegal*	Illegal*	Illegal*
Wyoming	Illegal*	Illegal*	Illegal*	Illegal*	Illegal*	Illegal*
Alabama	Illegal	Illegal	Illegal	Illegal	Medical	Medical
Mississippi	Illegal	Illegal	Illegal	Illegal	Medical	Medical
South Dakota	Illegal	Illegal	Illegal	Medical	Medical	Medical
Virginia	Illegal*	Illegal*	Medical	Recreational	Recreational	Recreational
Utah	Illegal	Medical	Medical	Medical	Medical	Medical
Missouri	Illegal	Medical	Medical	Medical	Medical	Recreational**
Arkansas	Medical	Medical	Medical	Medical	Medical	Medical
Florida	Medical	Medical	Medical	Medical	Medical	Medical
Hawaii	Medical	Medical	Medical	Medical	Medical	Medical
Louisiana	Medical	Medical	Medical	Medical	Medical	Medical
New Hampshire	Medical	Medical	Medical	Medical	Medical	Medical
North Dakota	Medical	Medical	Medical	Medical	Medical	Medical
Ohio	Medical	Medical	Medical	Medical	Medical	Medical
Oklahoma	Medical	Medical	Medical	Medical	Medical	Medical
Pennsylvania	Medical	Medical	Medical	Medical	Medical	Medical
West Virginia	Medical	Medical	Medical	Medical	Medical	Medical
Delaware	Medical	Medical	Medical	Medical	Medical	Recreational
Maryland	Medical	Medical	Medical	Medical	Medical	Recreational**
Minnesota	Medical	Medical	Medical	Medical	Medical	Recreational
Rhode Island	Medical	Medical	Medical	Medical	Recreational	Recreational**
Arizona	Medical	Medical	Medical	Recreational**	Recreational**	Recreational**
Connecticut	Medical	Medical	Medical	Recreational	Recreational	Recreational**
Montana	Medical	Medical	Medical	Recreational	Recreational**	Recreational**
New Jersey	Medical	Medical	Medical	Recreational	Recreational**	Recreational**
New Mexico	Medical	Medical	Medical	Recreational	Recreational**	Recreational**
New York	Medical	Medical	Medical	Recreational	Recreational	Recreational**
Illinois	Medical	Medical	Recreational**	Recreational**	Recreational**	Recreational**
Michigan	Medical	Recreational	Recreational**	Recreational**	Recreational**	Recreational**
Alaska	Recreational**	Recreational**	Recreational**	Recreational**	Recreational**	Recreational**
California	Recreational**	Recreational**	Recreational**	Recreational**	Recreational**	Recreational**
Colorado	Recreational**	Recreational**	Recreational**	Recreational**	Recreational**	Recreational**
Maine	Recreational	Recreational	Recreational**	Recreational**	Recreational**	Recreational**
Massachusetts	Recreational	Recreational**	Recreational**	Recreational**	Recreational**	Recreational**

Nevada	Recreational**	Recreational**	Recreational**	Recreational**	Recreational**	Recreational**
Oregon	Recreational**	Recreational**	Recreational**	Recreational**	Recreational**	Recreational**
Vermont	Recreational	Recreational	Recreational	Recreational	Recreational	Recreational**
Washington State	Recreational**	Recreational**	Recreational**	Recreational**	Recreational**	Recreational**
Washington, DC	Recreational	Recreational	Recreational	Recreational	Recreational	Recreational

Note. *Some exemptions for CBD products and low THC cannabis; **State-regulated cannabis retailers operational

Table A2. Date of recreational cannabis legalization by state

	Date of approval	Date of legalization	Date retail sales permitted
Alaska	Nov 2014	Feb 2015	Oct 2016
Arizona	Nov 2020	Nov 2020	Mar 2021
California	Nov 2016	Nov 2016	Jan 2018
Colorado	Nov 2012	Dec 2012	Jan 2014
Connecticut	Jun 2021	Jul 2021	Jan 2023
Delaware	Mar 2023	Apr 2023	n/a
Illinois	Jun 2019	Jan 2020	Jan 2020
Maine	Nov 2016	Jan 2017	Oct 2020
Maryland	Apr 2023	May 2023	July 2023
Massachusetts	Nov 2016	Dec 2016	Nov 2018
Michigan	Nov 2018	Dec 2018	Dec 2019
Minnesota	May 2023	Aug 2023	n/a
Missouri	Nov 2022	Dec 2022	Feb 2023
Montana	Nov 2020	Jan 2021	Jan 2022
Nevada	Nov 2016	Jan 2017	Jul 2017
New Jersey	Nov 2020	Jan 2021	Apr 2022
New Mexico	Mar 2021	Jun 2021	Apr 2022
New York	Mar 2021	Mar 2021	Dec 2022
Oregon	Nov 2014	Jul 2015	Oct 2015
Rhode Island	May 2022	May 2022	Dec 2022
Vermont	Jan 2018	Jul 2018	Oct 2022
Virginia	Apr 2021	Jul 2021	n/a
Washington, DC	Nov 2014	Feb 2015	n/a
Washington State	Nov 2012	Dec 2012	Jul 2014

Table A3. Date of medical cannabis legalization by state

	Date of legalization (medical)
Alabama	2021
Arkansas	2016
Delaware	2011
Florida	2016
Hawaii	2000
Kentucky	2023
Louisiana	2016
Maryland	2014
Minnesota	2014
Mississippi	2022
Missouri	2018
New Hampshire	2013
North Dakota	2016
Ohio	2016
Oklahoma	2018
Pennsylvania	2016
South Dakota	2021
Utah	2018
West Virginia	2017

Table A4. Coding guide used to evaluate marketing channel restriction level

CHANNEL	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5
		PRODUCTS ONLY	PRODUCTS ONLY	PRODUCTS AND BRANDS	PRODUCTS AND BRANDS
Regular postal mail	[No restrictions].	[Permitted without age verification, subject to some restrictions.]	Advertisements are permitted via mail provided that the mail is addressed and sent to an individual who of the legal age to consume marijuana and is identified by name.	[Permitted without age verification, subject to some restrictions.]	Advertisements are permitted via mail provided that the mail is addressed and sent to an individual who of the legal age to consume marijuana and is identified by name.
Websites	[No restrictions].	Advertisements are permitted if at least 70% of the audience is expected to be of the legal age to consume marijuana. Does not require all of the audience to be of the legal age.	At least one of the following: (1) Advertisements are permitted on web pages that ensure all individuals visiting the web page are of the legal age to consume marijuana; or (2) Unsolicited advertising is prohibited.	Advertisements are permitted if at least 70% of the audience is expected to be of the legal age to consume marijuana. Does not require all of the audience to be of the legal age.	At least one of the following: (1) Advertisements are permitted on web pages that ensure all individuals visiting the web page are of the legal age to consume marijuana; or (2) Unsolicited advertising is prohibited.
Email or text messages	No restrictions or advertisements are permitted if at least 70% of the audience is expected to be of the legal age to consume marijuana. Does not require all of the audience to be of the legal age.	Advertisements are permitted provided that the advertisement is addressed and sent to an individual who is of the legal age to consume marijuana and is identified by name.	Advertisements are permitted if sent to individuals who have registered to receive communications from retailers. Such individuals must be of the legal age to consume marijuana.	Advertisements are permitted provided that the advertisement is addressed and sent to an individual who is of the legal age to consume marijuana and is identified by name.	Advertisements are permitted if sent to individuals who have registered to receive communications from retailers. Such individuals must be of the legal age to consume marijuana.
Bars, pubs, nightclubs	[No restrictions].	Advertisements are permitted provided that the bar, pub, or nightclub only	Advertisements are prohibited in establishments that do not	Advertisements are permitted provided that the bar, pub, or nightclub only	Advertisements are prohibited in establishments that do not

		allows adults or individuals of the legal age to consume marijuana to enter.	regularly sell cannabis.	allows adults or individuals of the legal age to consume marijuana to enter.	regularly sell cannabis.
Inside stores that sell marijuana	[No restrictions].	[Advertisements restricted based on size, place, or other content.]	Advertisements inside stores may only include information on product availability and price.	[Advertisements restricted based on size, place, or other content.]	Advertisements inside stores may only include information on product availability and price.
Outside stores that sell marijuana	[No restrictions].	In addition to the business name, location of the business, and nature of the business, outdoor signs can include images and logos. Images and logos cannot include plants, products, or appeal to children. The size of these signs is restricted by legislation.	Outdoor signs stating the business name, location of the business, nature of the business are permitted. The size of these signs is restricted by legislation. Displays of marijuana products that are visible to persons outside the store are prohibited.	In addition to the business name, location of the business, and nature of the business, outdoor signs can include images and logos. Images and logos cannot include plants, products, or appeal to children. The size of these signs is restricted by legislation.	Outdoor signs stating the business name, location of the business, nature of the business are permitted. The size of these signs is restricted by legislation. Displays of marijuana products that are visible to persons outside the store are prohibited.
Events (e.g., sporting events, concerts, festivals)	[No restrictions].	Advertisements are permitted if at least 70% of the attendees is expected to be of the legal age to consume marijuana. Does not require all of the audience to be of the legal age.	Advertisements are permitted if the event restricts entry to individuals of the legal age to consume marijuana.	Advertisements are permitted if at least 70% of the attendees is expected to be of the legal age to consume marijuana. Does not require all of the audience to be of the legal age.	Advertisements are permitted if the event restricts entry to individuals of the legal age to consume marijuana.
TV or radio	[No restrictions].	Advertisements are permitted if at least 70% of the audience is expected to be of the legal age to consume marijuana. Does not require all of the audience to	Informational promotion is permitted provided that reasonable steps have been taken to ensure that the promotion cannot be	Advertisements are permitted if at least 70% of the audience is expected to be of the legal age to consume marijuana. Does not require all of the audience to	Informational promotion is permitted provided that reasonable steps have been taken to ensure that the promotion cannot be

		be of the legal age.	accessed by a young person.	be of the legal age.	accessed by a young person.
Billboards or posters	[No restrictions].	At least one of the following: (1) Billboards may be used for the sole purpose of identifying the name of the business, the nature of the business, and providing the public with directional information to the licensed retail outlet. They must include warnings and the legal age of purchase and possession. Images and logos are permitted, but they cannot contain plants, products, or appeal to children; or (2) At least 70% of the viewing audience must be of the legal age to consume marijuana. Does not require all of the audience to be of the legal age.	All billboards and/or signage visible to the general public are prohibited. Reasonable steps have been taken to ensure that the promotion cannot be accessed by a young person.	At least one of the following: (1) Billboards may be used for the sole purpose of identifying the name of the business, the nature of the business, and providing the public with directional information to the licensed retail outlet. They must include warnings and the legal age of purchase and possession. Images and logos are permitted, but they cannot contain plants, products, or appeal to children; or (2) At least 70% of the viewing audience must be of the legal age to consume marijuana. Does not require all of the audience to be of the legal age.	All billboards and/or signage visible to the general public are prohibited. Reasonable steps have been taken to ensure that the promotion cannot be accessed by a young person.
Print newspaper or magazines	No restrictions or advertisements in established publications intended for general readership are permitted with restrictions. No warnings are necessary if only	Advertisements are permitted in publications if at least 70% of the target audience is of the legal age to consume marijuana. Does not require all of the audience to	Advertisements are permitted in cannabis-related publications sold at legal cannabis retailers or behind the counter in establishments where persons under the legal	Advertisements are permitted in publications if at least 70% of the target audience is of the legal age to consume marijuana. Does not require all of the audience to	Advertisements are permitted in cannabis-related publications sold at legal cannabis retailers or behind the counter in establishments where persons under the legal

	the business information is presented without product information or illustrations. If illustrations are included, specific warning statements will be mandatory.	be of the legal age.	age to consume marijuana are present. Reasonable steps have been taken to ensure that the promotion cannot be accessed by a young person.	be of the legal age.	age to consume marijuana are present. Reasonable steps have been taken to ensure that the promotion cannot be accessed by a young person.
Social media	[No restrictions].	Advertisements on social media are permitted if at least 70% of the target audience is of the legal age to consume marijuana. Does not require all of the audience to be of the legal age. OR Use of warning statements on social media posts are encouraged.	At least one of the following: (1) Advertising is permitted via social media provided that reasonable steps have been taken to ensure that the promotion cannot be accessed by a young person or an individual under the legal age to consume marijuana; or (2) Unsolicited advertising is prohibited.	Advertisements on social media are permitted if at least 70% of the target audience is of the legal age to consume marijuana. Does not require all of the audience to be of the legal age. OR Use of warning statements on social media posts are encouraged.	At least one of the following: (1) Advertising is permitted via social media provided that reasonable steps have been taken to ensure that the promotion cannot be accessed by a young person or an individual under the legal age to consume marijuana; or (2) Unsolicited advertising is prohibited.

Table A5. Marketing restriction strength scores

	AK	AZ	CA	CO	CT	IL	MA	MD	ME	MI	MO	MT	NJ	NM	NV	NY	OR	RI	VT	WA
Regular postal mail	5	1	2	1	1	2	1	1	3	4	4	1	1	5	1	4	5	4	4	4
Websites	1	1	2	3	1	3	5	1	3	4	4	5	4	4	5	4	5	5	4	4
Email or text messages	4	1	1	3	1	3	5	4	3	1	1	1	1	4	5	5	4	4	5	4
Bars, pubs, nightclubs	1	4	1	1	4	1	1	4	3	4	1	4	4	4	1	1	5	4	1	4
Inside stores	1	1	1	1	4	1	1	4	3	1	1	1	4	1	4	4	1	1	4	4
Outside stores	1	5	2	1	4	1	4	5	3	1	5	5	5	1	5	5	1	4	5	5
Events & sponsorships	1	1	1	2	1	2	4	5	3	4	4	4	3	4	4	4	5	4	4	4
TV or radio	1	1	3	2	1	2	1	1	3	4	4	4	4	4	4	4	4	4	5	4
Billboards or posters	1	1	1	1	1	2	5	4	5	4	4	4	4	4	4	5	5	5	5	4
Print	1	1	2	2	1	2	1	1	3	4	4	4	4	4	4	4	4	4	4	4
Social media	1	1	2	3	1	2	5	4	3	4	4	4	4	4	4	3	5	5	4	4
Total score	**18**	**18**	**18**	**20**	**20**	**21**	**33**	**34**	**35**	**35**	**36**	**37**	**38**	**39**	**41**	**43**	**44**	**44**	**45**	**45**

Table A6. Mixed effects logistic regression for noticing cannabis advertising across legal statuses

	% Noticed	OR (95%CI)	P-value
Legal status of cannabis			
Recreational	58.89%	1.86 (1.67, 2.06)	<0.001
Medical	41.45%	1.25 (1.13, 1.38)	<0.001
Illegal	35.37%	Ref	Ref
Survey year			
2018/Wave 1	45.21%	Ref	Ref
2019/Wave 2	56.23%	1.27 (1.22, 1.32)	<0.001
2020/Wave 3	46.63%	0.94 (0.90, 0.98)	0.002
2021/Wave 4	50.00%	1.11 (1.07, 1.16)	<0.001
2022/Wave 5	54.04%	1.31 (1.26, 1.36)	<0.001
2023/Wave 6	54.29%	1.22 (1.17, 1.27)	<0.001
Age			
16-20 years	51.78%	Ref	Ref
21-30 years	60.74%	0.90 (0.86, 0.94)	<0.001
31-50 years	53.57%	0.64 (0.61, 0.66)	<0.001
51-65 years	43.98%	0.44 (0.42, 0.46)	<0.001
Frequency of use			
Never consumer	45.39%	Ref	Ref
Consumed more than 12 months ago	51.89%	1.38 (1.34, 1.41)	<0.001
Past-12-month consumer	52.75%	1.22 (1.17, 1.26)	<0.001
Monthly to weekly consumer	59.47%	1.56 (1.51, 1.61)	<0.001
Daily Consumer	59.82%	1.62 (1.57, 1.68)	<0.001
Sex at birth			
Female	48.60%	0.79 (0.77, 0.80)	<0.001
Male	55.00%	Ref	Ref
Education			
Less than high school	47.11%	Ref	Ref

High school diploma or equivalent	46.54%	1.10 (1.05, 1.15)	<0.001
Some university/college	51.78%	1.43 (1.37, 1.49)	<0.001
Bachelor's degree or higher	56.55%	1.84 (1.76, 1.93)	<0.001
Ethnicity			
White (non-Hispanic)	50.48%	Ref	Ref
White (Hispanic)	60.85%	1.31 (1.26, 1.36)	<0.001
American Indian or Alaskan Native	61.22%	1.24 (1.14, 1.35)	<0.001
Asian	48.44%	0.80 (0.76, 0.84)	<0.001
Black or African American	51.45%	1.20 (1.16, 1.24)	<0.001
Native Hawaiian or Pacific Islander	54.48%	1.25 (1.09, 1.44)	0.001
Other/2+ races	57.45%	1.17 (1.11, 1.23)	<0.001
Unstated	47.93%	0.87 (0.80, 0.94)	<0.001
Income adequacy			
Difficult or very difficult	52.44%	1.13 (1.10, 1.15)	<0.001
Neither easy nor difficult	50.11%	Ref	Ref
Easy or very easy	54.71%	1.15 (1.12, 1.18)	<0.001
Not Stated	31.78%	0.43 (0.41, 0.46)	<0.001
Variance of random intercept			
τ^2	0.0841		
VPC or ICC[a]	0.0249		

[a]VPC variance partition coefficient, ICC intraclass correlation coefficient

Table A7. Past-12-month self-reported noticing at least 1 cannabis ad or promotion by state (grouped by restriction level)

	% Noticed (n)
Level 1 (Low strength restrictions)	
Alaska	66% (2160)
Arizona	61% (1562)
Colorado	62% (6244)
Illinois	53% (6084)
Missouri	51% (243)
New Mexico	65% (968)
Oregon	69% (6772)
Level 2 (Moderate strength restrictions)	
California	60% (7857)
Massachusetts	57% (6522)
Michigan	61% (2774)
Montana	61% (601)
Nevada	70% (3930)
New York	55% (1416)
Washington State	66% (8942)
Level 3 (High strength restrictions)	
Connecticut	54% (455)
Maine	57% (1373)
Maryland	54% (269)
New Jersey	51% (1777)
Rhode Island	42% (36)
Vermont	56% (143)

Table A8. Linear regression for noticing index (n=99,132)

	Mean (SD)	Beta (95%CI)	P-value
Strength of state marketing restrictions			
Level 1 (Low strength: Score 11-33)	1.51 (1.83)	Ref	Ref
Level 2 (Moderate strength: Score 34-39)	1.45 (1.77)	-0.01 (-0.04, 0.02)	0.537
Level 3 (High strength: Score 40-55)	1.17 (1.60)	-0.15 (-0.20, -0.10)	<0.001
Time since legal sales began			
<1 Year	1.16 (1.61)	Ref	Ref
1-3 Years	1.45 (1.79)	0.24 (0.21, 0.28)	<0.001
4+ Years	1.59 (1.84)	0.34 (0.30, 0.38)	<0.001
Age			
16-20 years	1.56 (2.12)	Ref	Ref
21-30 years	1.72 (2.21)	-0.13 (-0.20, -0.06)	0.001
31-50 years	1.49 (1.82)	-0.41 (-0.48, -0.34)	<0.001
51-65 years	1.20 (1.41)	-0.69 (-0.75, -0.62)	<0.001
Frequency of use			
Never consumer	1.22 (1.60)	Ref	Ref
Consumed more than 12 months ago	1.46 (1.68)	0.27 (0.24, 0.30)	<0.001
Past-12-month consumer	1.41 (1.72)	0.14 (0.10, 0.19)	<0.001
Monthly to weekly consumer	1.55 (1.85)	0.28 (0.24, 0.32)	<0.001
Daily Consumer	1.85 (2.23)	0.59 (0.54, 0.63)	<0.001
Sex at birth			
Female	1.43 (1.54)	-0.07 (-0.09, -0.04)	<0.001
Male	1.43 (2.23)	Ref	Ref
Education			
Less than high school	1.38 (2.00)	Ref	Ref
High school diploma or equivalent	1.36 (1.95)	0.11 (0.03, 0.18)	0.004
Some university/college	1.54 (1.93)	0.35 (0.28, 0.42)	<0.001
Bachelor’s degree or higher	1.44 (1.53)	0.35 (0.28, 0.42)	<0.001

Ethnicity			
White (non-Hispanic)	1.45 (1.75)	Ref	Ref
White (Hispanic)	1.60 (2.00)	0.04 (-0.01, 0.09)	0.080
American Indian or Alaskan Native	1.57 (1.93)	0.02 (-0.09, 0.14)	0.670
Asian	1.14 (1.48)	-0.30 (-0.35, -0.24)	<0.001
Black or African American	1.32 (1.88)	-0.18 (-0.23, -0.12)	<0.001
Native Hawaiian or Pacific Islander	1.65 (1.77)	0.08 (-0.10, -0.27)	0.368
Other/2+ races	1.76 (1.91)	0.19 (0.12, 0.26)	<0.001
Unstated	1.34 (1.78)	-0.09 (-0.19, 0.01)	0.065
Income adequacy			
Difficult or very difficult	1.58 (1.91)	Ref	Ref
Neither easy nor difficult	1.39 (1.75)	-0.16 (-0.19, -0.13)	<0.001
Easy or very easy	1.45 (1.70)	-0.11 (-0.14, -0.07)	<0.001
Not Stated	0.86 (1.64)	-0.71 (-0.78, -0.63)	<0.001

Table A9. Mixed effects logistic regression for noticing cannabis advertising in postal mail within recreational states (n=99,132)

	% Noticed	OR (95%CI)	P-value
Strength of channel marketing restrictions			
Level 1 (Low strength)	2.72%	Ref	Ref
Level 2 (Low-moderate strength)	2.73%	0.95 (0.67, 1.35)	0.778
Level 3 (Moderate strength)	1.67%	0.68 (0.36, 1.30)	0.247
Level 4 (Moderate-high strength)	3.14%	1.12 (0.87, 1.46)	0.380
Level 5 (High strength)	3.27%	1.08 (0.79, 1.48)	0.649
Time since legal sales began			
<1 Year	2.67%	Ref	Ref
1-3 Years	2.91%	1.09 (0.96, 1.23)	0.190
4+ Years	2.91%	1.18 (1.01, 1.39)	0.043
Age			
16-20 years	2.54%	Ref	Ref
21-30 years	3.52%	1.16 (0.97, 1.38)	0.109
31-50 years	3.38%	1.05 (0.89, 1.25)	0.574
51-65 years	1.82%	0.58 (0.48, 0.70)	<0.001
Frequency of use			
Never consumer	2.65%	Ref	Ref
Consumed more than 12 months ago	2.99%	1.24 (1.12, 1.37)	<0.001
Past-12-month consumer	2.06%	0.80 (0.69, 0.94)	0.006
Monthly to weekly consumer	3.42%	1.23 (1.09, 1.38)	0.001
Daily Consumer	3.11%	1.19 (1.06, 1.34)	0.004
Sex at birth			
Female	2.25%	0.67 (0.62, 0.73)	<0.001
Male	3.48%	Ref	Ref
Education			
Less than high school	2.39%	Ref	Ref

High school diploma or equivalent	2.42%	1.08 (0.89, 1.31)	0.460
Some university/college	2.65%	1.28 (1.06, 1.54)	0.011
Bachelor's degree or higher	3.49%	1.62 (1.33, 1.96)	<0.001
Ethnicity			
White (non-Hispanic)	2.59%	Ref	Ref
White (Hispanic)	4.10%	1.44 (1.29, 1.61)	<0.001
American Indian or Alaskan Native	3.39%	1.33 (1.01, 1.75)	0.044
Asian	2.64%	0.88 (0.73, 1.06)	0.172
Black or African American	3.64%	1.34 (1.17, 1.52)	<0.001
Native Hawaiian or Pacific Islander	3.83%	1.41 (0.87, 2.30)	0.162
Other/2+ races	3.11%	1.22 (1.01, 1.46)	0.038
Unstated	2.17%	0.87 (0.63, 1.20)	0.400
Income adequacy			
Difficult or very difficult	2.61%	Ref	Ref
Neither easy nor difficult	2.39%	0.88 (0.80, 0.97)	0.012
Easy or very easy	3.70%	1.30 (1.18, 1.43)	<0.001
Not Stated	2.13%	0.79 (0.61, 1.03)	0.083
Variance of random intercept			
τ^2	0.0375		
VPC or ICC[a]	0.0113		

[a]VPC variance partition coefficient, ICC intraclass correlation coefficient

Table A10. Mixed effects logistic regression for noticing cannabis advertising on websites within recreational states (n=99,132)

	% Noticed	OR (95%CI)	P-value
Strength of channel marketing restrictions			
Level 1 (Low strength)	15.44%	Ref	Ref
Level 2 (Low-moderate strength)	16.34%	0.96 (0.64, 1.43)	0.823
Level 3 (Moderate strength)	17.03%	1.13 (0.86, 1.48)	0.379
Level 4 (Moderate-high strength)	16.78%	1.06 (0.85, 1.34)	0.603
Level 5 (High strength)	16.12%	1.07 (0.83, 1.36)	0.615
Time since legal sales began			
<1 Year	15.34%	Ref	Ref
1-3 Years	16.95%	1.00 (0.94, 1.06)	0.914
4+ Years	16.20%	0.81 (0.74, 0.87)	<0.001
Age			
16-20 years	19.38%	Ref	Ref
21-30 years	20.02%	0.84 (0.78, 0.90)	<0.001
31-50 years	17.26%	0.67 (0.63, 0.72)	<0.001
51-65 years	11.86%	0.44 (0.41, 0.48)	<0.001
Frequency of use			
Never consumer	13.15%	Ref	Ref
Consumed more than 12 months ago	15.83%	1.35 (1.29, 1.42)	<0.001
Past-12-month consumer	15.37%	1.19 (1.12, 1.27)	<0.001
Monthly to weekly consumer	18.44%	1.45 (1.37, 1.54)	<0.001
Daily Consumer	22.43%	1.85 (1.75, 1.94)	<0.001
Sex at birth			
Female	14.55%	0.75 (0.72, 0.78)	<0.001
Male	18.19%	Ref	Ref
Education			
Less than high school	17.10%	Ref	Ref

High school diploma or equivalent	16.41%	1.09 (1.01, 1.18)	0.031
Some university/college	17.18%	1.27 (1.18, 1.37)	<0.001
Bachelor's degree or higher	15.32%	1.22 (1.13, 1.33)	<0.001
Ethnicity			
White (non-Hispanic)	15.90%	Ref	Ref
White (Hispanic)	19.56%	1.11 (1.05, 1.17)	<0.001
American Indian or Alaskan Native	16.09%	0.89 (0.77, 1.02)	0.087
Asian	14.27%	0.88 (0.81, 0.96)	0.005
Black or African American	16.68%	0.93 (0.87, 0.99)	0.024
Native Hawaiian or Pacific Islander	18.82%	1.08 (0.85, 1.37)	0.525
Other/2+ races	19.03%	1.09 (1.01, 1.18)	0.037
Unstated	14.37%	0.86 (0.75, 0.98)	0.028
Income adequacy			
Difficult or very difficult	18.43%	Ref	Ref
Neither easy nor difficult	15.70%	0.83 (0.80, 0.86)	<0.001
Easy or very easy	15.59%	0.82 (0.79, 0.86)	<0.001
Not Stated	10.24%	0.49 (0.43, 0.55)	<0.001
Variance of random intercept			
τ^2	0.0294		
VPC or ICC[a]	0.0089		

[a]VPC variance partition coefficient, ICC intraclass correlation coefficient

Table A11. Mixed effects logistic regression for noticing cannabis advertising in email or texts within recreational states (n=99,132)

	% Noticed	OR (95%CI)	P-value
Strength of channel marketing restrictions			
Level 1 (Low strength)	8.52%	Ref	Ref
Level 3 (Moderate strength)	8.71%	0.97 (0.70, 1.35)	0.868
Level 4 (Moderate-high strength)	8.96%	1.02 (0.78, 1.34)	0.871
Level 5 (High strength)	8.17%	0.96 (0.71, 1.32)	0.820
Time since legal sales began			
<1 Year	7.51%	Ref	Ref
1-3 Years	8.74%	1.02 (0.94, 1.10)	0.658
4+ Years	9.11%	0.97 (0.87, 1.08)	0.549
Age			
16-20 years	7.12%	Ref	Ref
21-30 years	10.72%	1.16 (1.05, 1.29)	0.006
31-50 years	9.19%	0.99 (0.89, 1.10)	0.870
51-65 years	7.05%	0.84 (0.75, 0.94)	0.002
Frequency of use			
Never consumer	5.32%	Ref	Ref
Consumed more than 12 months ago	6.88%	1.31 (1.22, 1.40)	<0.001
Past-12-month consumer	6.51%	1.20 (1.09, 1.32)	<0.001
Monthly to weekly consumer	11.71%	2.23 (2.07, 2.40)	<0.001
Daily Consumer	17.15%	3.42 (3.20, 3.66)	<0.001
Sex at birth			
Female	7.76%	0.81 (0.77, 0.85)	<0.001
Male	9.58%	Ref	Ref
Education			
Less than high school	7.53%	Ref	Ref
High school diploma or equivalent	8.96%	1.08 (0.97, 1.21)	0.178

Some university/college	9.62%	1.26 (1.13, 1.41)	<0.001
Bachelor's degree or higher	7.68%	1.20 (1.07, 1.34)	0.002
Ethnicity			
White (non-Hispanic)	8.11%	Ref	Ref
White (Hispanic)	10.68%	1.19 (1.11, 1.28)	<0.001
American Indian or Alaskan Native	10.57%	1.13 (0.95, 1.33)	0.163
Asian	6.50%	0.93 (0.82, 1.05)	0.214
Black or African American	11.06%	1.22 (1.13, 1.32)	<0.001
Native Hawaiian or Pacific Islander	10.90%	1.27 (0.94, 1.71)	0.126
Other/2+ races	10.74%	1.21 (1.09, 1.34)	<0.001
Unstated	6.71%	0.83 (0.69, 1.01)	0.060
Income adequacy			
Difficult or very difficult	10.23%	Ref	Ref
Neither easy nor difficult	8.00%	0.79 (0.75, 0.83)	<0.001
Easy or very easy	8.11%	0.84 (0.79, 0.88)	<0.001
Not Stated	5.41%	0.56 (0.47, 0.66)	<0.001
Variance of random intercept			
τ^2	0.0519		
VPC or ICC[a]	0.0155		

[a]VPC variance partition coefficient, ICC intraclass correlation coefficient

Table A12. Mixed effects logistic regression for noticing cannabis advertising in bars, pubs, or nightclubs (n=99,132)

	% Noticed	OR (95%CI)	P-value
Strength of channel marketing restrictions			
Level 1 (Low strength)	6.49%	Ref	Ref
Level 3 (Moderate strength)	5.30%	0.90 (0.52, 1.57)	0.722
Level 4 (Moderate-high strength)	5.70%	0.92 (0.73, 1.16)	0.484
Level 5 (High strength)	6.99%	1.15 (0.63, 2.08)	0.652
Time since legal sales began			
<1 Year	5.13%	Ref	Ref
1-3 Years	5.79%	1.21 (1.10, 1.34)	<0.001
4+ Years	6.60%	1.29 (1.14, 1.47)	<0.001
Age			
16-20 years	6.04%	Ref	Ref
21-30 years	9.58%	1.13 (1.01, 1.27)	0.033
31-50 years	6.65%	0.72 (0.64, 0.81)	<0.001
51-65 years	2.67%	0.28 (0.25, 0.32)	<0.001
Frequency of use			
Never consumer	5.18%	Ref	Ref
Consumed more than 12 months ago	6.41%	1.45 (1.34, 1.55)	<0.001
Past-12-month consumer	5.60%	1.07 (0.97, 1.19)	0.175
Monthly to weekly consumer	6.52%	1.20 (1.10, 1.31)	<0.001
Daily Consumer	6.57%	1.23 (1.13, 1.34)	<0.001
Sex at birth			
Female	5.56%	0.86 (0.81, 0.91)	<0.001
Male	6.43%	Ref	Ref
Education			
Less than high school	4.51%	Ref	Ref
High school diploma or equivalent	5.52%	1.43 (1.25, 1.65)	<0.001

Some university/college	5.81%	1.73 (1.51, 1.98)	<0.001
Bachelor's degree or higher	6.79%	2.16 (1.88, 2.48)	<0.001
Ethnicity			
White (non-Hispanic)	5.30%	Ref	Ref
White (Hispanic)	8.13%	1.28 (1.18, 1.39)	<0.001
American Indian or Alaskan Native	8.52%	1.49 (1.24, 1.79)	<0.001
Asian	5.97%	0.96 (0.84, 1.09)	0.482
Black or African American	7.85%	1.40 (1.27, 1.53)	<0.001
Native Hawaiian or Pacific Islander	7.61%	1.19 (0.84, 1.69)	0.337
Other/2+ races	6.86%	1.15 (1.02, 1.31)	0.028
Unstated	6.92%	1.25 (1.03, 1.50)	0.022
Income adequacy			
Difficult or very difficult	6.22%	Ref	Ref
Neither easy nor difficult	5.60%	0.88 (0.82, 0.94)	<0.001
Easy or very easy	6.40%	0.99 (0.93, 1.06)	0.792
Not Stated	3.53%	0.50 (0.41, 0.62)	<0.001
Variance of random intercept			
τ^2	0.0521		
VPC or ICC[a]	0.0156		

[a]VPC variance partition coefficient, ICC intraclass correlation coefficient

Table A13. Mixed effects logistic regression for noticing cannabis advertising inside stores that sell marijuana within recreational states (n=99,132)

	% Noticed	OR (95%CI)	P-value
Strength of channel marketing restrictions			
Level 1 (Low strength)	18.17%	Ref	Ref
Level 3 (Moderate strength)	17.99%	1.09 (0.65, 1.81)	0.753
Level 4 (Moderate-high strength)	14.91%	0.85 (0.67, 1.08)	0.180
Time since legal sales began			
<1 Year	12.11%	Ref	Ref
1-3 Years	15.36%	1.36 (1.27, 1.45)	<0.001
4+ Years	20.47%	1.36 (1.24, 1.48)	<0.001
Age			
16-20 years	13.81%	Ref	Ref
21-30 years	21.73%	1.13 (1.05, 1.23)	0.002
31-50 years	17.44%	0.83 (0.77, 0.90)	<0.001
51-65 years	13.51%	0.66 (0.61, 0.72)	<0.001
Frequency of use			
Never consumer	8.50%	Ref	Ref
Consumed more than 12 months ago	14.00%	1.69 (1.60, 1.78)	<0.001
Past-12-month consumer	19.60%	2.37 (2.22, 2.53)	<0.001
Monthly to weekly consumer	24.03%	3.16 (2.98, 3.35)	<0.001
Daily Consumer	30.01%	4.12 (3.90, 4.35)	<0.001
Sex at birth			
Female	17.24%	1.05 (1.01, 1.08)	0.013
Male	16.39%	Ref	Ref
Education			
Less than high school	12.94%	Ref	Ref
High school diploma or equivalent	17.53%	1.33 (1.22, 1.45)	<0.001
Some university/college	19.41%	1.61 (1.47, 1.75)	<0.001

Bachelor's degree or higher	14.30%	1.39 (1.27, 1.52)	<0.001
Ethnicity			
White (non-Hispanic)	17.01%	Ref	Ref
White (Hispanic)	17.69%	0.96 (0.91, 1.02)	0.184
American Indian or Alaskan Native	20.42%	1.03 (0.90, 1.17)	0.673
Asian	10.25%	0.76 (0.69, 0.84)	<0.001
Black or African American	14.62%	0.81 (0.76, 0.87)	<0.001
Native Hawaiian or Pacific Islander	22.22%	1.25 (0.99, 1.57)	0.061
Other/2+ races	22.33%	1.20 (1.11, 1.30)	<0.001
Unstated	14.59%	0.89 (0.78, 1.03)	0.107
Income adequacy			
Difficult or very difficult	20.22%	Ref	Ref
Neither easy nor difficult	16.04%	0.83 (0.79, 0.86)	<0.001
Easy or very easy	14.99%	0.82 (0.78, 0.85)	<0.001
Not Stated	8.06%	0.41 (0.36, 0.48)	<0.001
Variance of random intercept			
τ^2	0.0556		
VPC or ICC[a]	0.0166		

[a]VPC variance partition coefficient, ICC intraclass correlation coefficient

Table A14. Mixed effects logistic regression for noticing cannabis advertising outside stores that sell marijuana within recreational states (n=99,132)

	% Noticed	OR (95%CI)	P-value
Strength of channel marketing restrictions			
Level 1 (Low strength)	26.56%	Ref	Ref
Level 2 (Low-moderate strength)	33.67%	1.75 (0.80, 3.86)	0.163
Level 3 (Moderate strength)	30.05%	1.37 (0.62, 3.02)	0.440
Level 4 (Moderate-high strength)	20.40%	0.93 (0.56, 1.56)	0.795
Level 5 (High strength)	22.38%	0.89 (0.61, 1.32)	0.571
Time since legal sales began			
<1 Year	16.50%	Ref	Ref
1-3 Years	21.90%	1.51 (1.43, 1.60)	<0.001
4+ Years	29.73%	1.38 (1.27, 1.49)	<0.001
Age			
16-20 years	27.19%	Ref	Ref
21-30 years	23.96%	0.70 (0.66, 0.75)	<0.001
31-50 years	22.69%	0.59 (0.55, 0.62)	<0.001
51-65 years	25.08%	0.63 (0.59, 0.68)	<0.001
Frequency of use			
Never consumer	24.00%	Ref	Ref
Consumed more than 12 months ago	27.68%	1.17 (1.12, 1.21)	<0.001
Past-12-month consumer	23.63%	0.89 (0.85, 0.94)	<0.001
Monthly to weekly consumer	19.77%	0.74 (0.70, 0.78)	<0.001
Daily Consumer	21.27%	0.83 (0.79, 0.87)	<0.001
Sex at birth			
Female	25.00%	1.09 (1.06, 1.12)	<0.001
Male	23.12%	Ref	Ref
Education			
Less than high school	24.04%	Ref	Ref

High school diploma or equivalent	20.01%	0.95 (0.88, 1.02)	0.187
Some university/college	24.88%	1.26 (1.18, 1.36)	<0.001
Bachelor's degree or higher	25.54%	1.41 (1.31, 1.52)	<0.001
Ethnicity			
White (non-Hispanic)	25.85%	Ref	Ref
White (Hispanic)	20.82%	0.82 (0.78, 0.87)	<0.001
American Indian or Alaskan Native	22.59%	0.81 (0.72, 0.92)	0.001
Asian	17.21%	0.62 (0.57, 0.67)	<0.001
Black or African American	15.48%	0.70 (0.66, 0.75)	<0.001
Native Hawaiian or Pacific Islander	24.26%	0.89 (0.71, 1.11)	0.296
Other/2+ races	29.10%	1.12 (1.05, 1.21)	0.001
Unstated	22.08%	0.91 (0.81, 1.02)	0.094
Income adequacy			
Difficult or very difficult	24.64%	Ref	Ref
Neither easy nor difficult	23.64%	0.97 (0.93, 1.00)	0.077
Easy or very easy	24.94%	0.97 (0.94, 1.01)	0.190
Not Stated	12.72%	0.45 (0.40, 0.51)	<0.001
Variance of random intercept			
τ^2	0.1355		
VPC or ICC[a]	0.0396		

[a]VPC variance partition coefficient, ICC intraclass correlation coefficient

Table A15. Mixed effects logistic regression for noticing cannabis advertising at events within recreational states. (n=99,132)

	% Noticed	OR (95%CI)	P-value
Strength of channel marketing restrictions			
Level 1 (Low strength)	4.85%	Ref	Ref
Level 2 (Low-moderate strength)	5.32%	0.92 (0.73, 1.16)	0.485
Level 3 (Moderate strength)	3.86%	0.79 (0.62, 1.00)	0.054
Level 4 (Moderate-high strength)	5.25%	1.01 (0.85, 1.20)	0.901
Level 5 (High strength)	4.16%	0.74 (0.57, 0.96)	0.023
Time since legal sales began			
<1 Year	4.00%	Ref	Ref
1-3 Years	5.10%	1.31 (1.18, 1.44)	<0.001
4+ Years	4.99%	1.34 (1.17, 1.52)	<0.001
Age			
16-20 years	6.07%	Ref	Ref
21-30 years	7.12%	0.89 (0.79, 1.00)	0.051
31-50 years	5.20%	0.61 (0.54, 0.68)	<0.001
51-65 years	2.56%	0.31 (0.27, 0.35)	<0.001
Frequency of use			
Never consumer	4.07%	Ref	Ref
Consumed more than 12 months ago	4.40%	1.24 (1.15, 1.35)	<0.001
Past-12-month consumer	4.34%	1.07 (0.95, 1.20)	0.253
Monthly to weekly consumer	5.76%	1.40 (1.28, 1.54)	<0.001
Daily Consumer	6.84%	1.77 (1.62, 1.93)	<0.001
Sex at birth			
Female	4.58%	0.91 (0.86, 0.96)	0.001
Male	5.15%	Ref	Ref
Education			
Less than high school	5.06%	Ref	Ref

High school diploma or equivalent	4.28%	1.03 (0.90, 1.19)	0.656
Some university/college	4.66%	1.29 (1.12, 1.47)	<0.001
Bachelor's degree or higher	5.41%	1.68 (1.46, 1.93)	<0.001
Ethnicity			
White (non-Hispanic)	4.42%	Ref	Ref
White (Hispanic)	7.10%	1.34 (1.23, 1.46)	<0.001
American Indian or Alaskan Native	6.23%	1.28 (1.04, 1.57)	0.022
Asian	3.73%	0.74 (0.63, 0.87)	<0.001
Black or African American	5.54%	1.12 (1.01, 1.25)	0.036
Native Hawaiian or Pacific Islander	5.03%	0.99 (0.65, 1.52)	0.970
Other/2+ races	6.41%	1.28 (1.13, 1.46)	<0.001
Unstated	4.09%	0.88 (0.69, 1.11)	0.274
Income adequacy			
Difficult or very difficult	5.20%	Ref	Ref
Neither easy nor difficult	4.24%	0.80 (0.75, 0.87)	<0.001
Easy or very easy	5.35%	1.00 (0.93, 1.08)	0.945
Not Stated	3.02%	0.53 (0.42, 0.66)	<0.001
Variance of random intercept			
τ^2	0.0107		
VPC or ICC[a]	0.0032		

[a]VPC variance partition coefficient, ICC intraclass correlation coefficient

Table A16. Mixed effects logistic regression for noticing cannabis advertising on TV or radio within recreational states (n=99,132)

	% Noticed	OR (95%CI)	P-value
Strength of channel marketing restrictions			
Level 1 (Low strength)	11.49%	Ref	Ref
Level 2 (Low-moderate strength)	11.17%	1.11 (0.63, 1.94)	0.723
Level 3 (Moderate strength)	11.42%	0.83 (0.47, 1.48)	0.529
Level 4 (Moderate-high strength)	11.58%	0.83 (0.57, 1.21)	0.320
Level 5 (High strength)	10.20%	0.79 (0.38, 1.66)	0.540
Time since legal sales began			
<1 Year	10.92%	Ref	Ref
1-3 Years	11.92%	0.94 (0.87, 1.00)	0.055
4+ Years	11.07%	0.71 (0.65, 0.78)	<0.001
Age			
16-20 years	12.62%	Ref	Ref
21-30 years	13.69%	1.05 (0.96, 1.14)	0.276
31-50 years	12.39%	0.94 (0.86, 1.02)	0.117
51-65 years	8.21%	0.60 (0.54, 0.65)	<0.001
Frequency of use			
Never consumer	11.01%	Ref	Ref
Consumed more than 12 months ago	11.35%	1.07 (1.01, 1.13)	0.017
Past-12-month consumer	9.61%	0.83 (0.77, 0.89)	<0.001
Monthly to weekly consumer	11.29%	0.97 (0.90, 1.03)	0.300
Daily Consumer	13.51%	1.14 (1.07, 1.21)	<0.001
Sex at birth			
Female	10.29%	0.79 (0.76, 0.82)	<0.001
Male	12.53%	Ref	Ref
Education			
Less than high school	12.09%	Ref	Ref

High school diploma or equivalent	12.22%	1.06 (0.97, 1.17)	0.189
Some university/college	12.06%	1.12 (1.02, 1.23)	0.014
Bachelor's degree or higher	10.07%	0.96 (0.87, 1.05)	0.363
Ethnicity			
White (non-Hispanic)	10.85%	Ref	Ref
White (Hispanic)	14.03%	1.21 (1.14, 1.29)	<0.001
American Indian or Alaskan Native	14.22%	1.08 (0.94, 1.25)	0.276
Asian	8.90%	0.78 (0.70, 0.87)	<0.001
Black or African American	12.32%	1.06 (0.99, 1.14)	0.118
Native Hawaiian or Pacific Islander	11.73%	0.93 (0.70, 1.24)	0.624
Other/2+ races	13.84%	1.16 (1.05, 1.27)	0.002
Unstated	12.09%	1.07 (0.92, 1.23)	0.392
Income adequacy			
Difficult or very difficult	12.47%	Ref	Ref
Neither easy nor difficult	10.94%	0.87 (0.82, 0.91)	<0.001
Easy or very easy	11.08%	0.89 (0.85, 0.94)	<0.001
Not Stated	8.78%	0.63 (0.55, 0.72)	<0.001
Variance of random intercept			
τ^2	0.1148		
VPC or ICC[a]	0.0337		

[a]VPC variance partition coefficient, ICC intraclass correlation coefficient

Table A17. Mixed effects logistic regression for noticing cannabis advertising on billboards or posters within recreational states (n=99,132)

	% Noticed	OR (95%CI)	P-value
Strength of channel marketing restrictions			
Level 1 (Low strength)	20.75%	Ref	Ref
Level 2 (Low-moderate strength)	34.36%	1.53 (0.66, 3.53)	0.321
Level 4 (Moderate-high strength)	29.76%	1.24 (0.80, 1.92)	0.346
Level 5 (High strength)	11.23%	0.42 (0.26, 0.68)	<0.001
Time since legal sales began			
<1 Year	16.07%	Ref	Ref
1-3 Years	27.30%	1.72 (1.63, 1.82)	<0.001
4+ Years	28.37%	1.43 (1.33, 1.54)	<0.001
Age			
16-20 years	26.18%	Ref	Ref
21-30 years	25.97%	0.78 (0.73, 0.83)	<0.001
31-50 years	25.15%	0.66 (0.62, 0.71)	<0.001
51-65 years	26.40%	0.68 (0.63, 0.72)	<0.001
Frequency of use			
Never consumer	24.56%	Ref	Ref
Consumed more than 12 months ago	27.92%	1.18 (1.13, 1.23)	<0.001
Past-12-month consumer	26.51%	1.05 (1.00, 1.11)	0.056
Monthly to weekly consumer	23.37%	0.90 (0.86, 0.95)	<0.001
Daily Consumer	25.71%	1.11 (1.06, 1.16)	<0.001
Sex at birth			
Female	26.81%	1.10 (1.07, 1.13)	<0.001
Male	24.77%	Ref	Ref
Education			
Less than high school	22.57%	Ref	Ref
High school diploma or equivalent	20.24%	1.00 (0.93, 1.08)	0.963

Some university/college	27.19%	1.47 (1.37, 1.58)	<0.001
Bachelor's degree or higher	28.19%	1.69 (1.57, 1.82)	<0.001
Ethnicity			
White (non-Hispanic)	27.42%	Ref	Ref
White (Hispanic)	23.68%	0.82 (0.78, 0.86)	<0.001
American Indian or Alaskan Native	19.63%	0.74 (0.65, 0.84)	<0.001
Asian	22.49%	0.69 (0.64, 0.74)	<0.001
Black or African American	17.17%	0.62 (0.59, 0.66)	<0.001
Native Hawaiian or Pacific Islander	24.21%	0.77 (0.62, 0.96)	0.023
Other/2+ races	28.67%	1.05 (0.98, 1.13)	0.203
Unstated	23.28%	0.90 (0.80, 1.01)	0.060
Income adequacy			
Difficult or very difficult	25.85%	Ref	Ref
Neither easy nor difficult	25.16%	0.97 (0.94, 1.01)	0.101
Easy or very easy	27.50%	1.03 (0.99, 1.07)	0.135
Not Stated	13.46%	0.45 (0.40, 0.51)	<0.001
Variance of random intercept			
τ^2	0.1509		
VPC or ICC[a]	0.0438		

[a]VPC variance partition coefficient, ICC intraclass correlation coefficient

Table A18. Mixed effects logistic regression for noticing cannabis advertising in print newspapers or magazines within recreational states (n=99,132)

	% Noticed	OR (95%CI)	P-value
Strength of channel marketing restrictions			
Level 1 (Low strength)	8.14%	Ref	Ref
Level 2 (Low-moderate strength)	13.07%	1.71 (0.76, 3.87)	0.196
Level 3 (Moderate strength)	7.49%	0.76 (0.22, 2.63)	0.668
Level 4 (Moderate-high strength)	7.60%	0.70 (0.38, 1.29)	0.254
Time since legal sales began			
<1 Year	6.58%	Ref	Ref
1-3 Years	8.44%	0.89 (0.81, 0.96)	0.004
4+ Years	10.57%	0.51 (0.46, 0.57)	<0.001
Age			
16-20 years	7.19%	Ref	Ref
21-30 years	8.01%	0.88 (0.79, 0.98)	0.019
31-50 years	9.45%	1.00 (0.90, 1.11)	0.987
51-65 years	9.43%	1.03 (0.93, 1.15)	0.543
Frequency of use			
Never consumer	7.14%	Ref	Ref
Consumed more than 12 months ago	9.44%	1.26 (1.19, 1.34)	<0.001
Past-12-month consumer	8.07%	1.09 (1.00, 1.18)	0.057
Monthly to weekly consumer	9.07%	1.23 (1.14, 1.33)	<0.001
Daily Consumer	11.94%	1.74 (1.62, 1.86)	<0.001
Sex at birth			
Female	8.26%	0.85 (0.82, 0.89)	<0.001
Male	9.64%	Ref	Ref
Education			
Less than high school	7.11%	Ref	Ref
High school diploma or equivalent	7.32%	0.98 (0.87, 1.10)	0.711

Some university/college	9.54%	1.26 (1.13, 1.41)	<0.001
Bachelor's degree or higher	9.67%	1.43 (1.28, 1.60)	<0.001
Ethnicity			
White (non-Hispanic)	9.25%	Ref	Ref
White (Hispanic)	9.25%	1.05 (0.98, 1.14)	0.169
American Indian or Alaskan Native	12.32%	1.31 (1.12, 1.53)	0.001
Asian	5.94%	0.69 (0.61, 0.78)	<0.001
Black or African American	6.67%	0.87 (0.79, 0.96)	0.003
Native Hawaiian or Pacific Islander	9.95%	1.17 (0.85, 1.59)	0.337
Other/2+ races	10.34%	1.13 (1.02, 1.26)	0.021
Unstated	8.23%	1.01 (0.85, 1.20)	0.940
Income adequacy			
Difficult or very difficult	9.26%	Ref	Ref
Neither easy nor difficult	8.43%	0.91 (0.86, 0.96)	0.001
Easy or very easy	9.52%	0.99 (0.93, 1.05)	0.663
Not Stated	5.31%	0.64 (0.54, 0.76)	<0.001
Variance of random intercept			
τ^2	0.3180		
VPC or ICC[a]	0.0881		

[a]VPC variance partition coefficient, ICC intraclass correlation coefficient

Table A19. Mixed effects logistic regression for noticing cannabis advertising on social media within recreational states (n=99,132)

	% Noticed	OR (95%CI)	P-value
Strength of channel marketing restrictions			
Level 1 (Low strength)	19.43%	Ref	Ref
Level 2 (Low-moderate strength)	20.58%	1.12 (0.97, 1.30)	0.119
Level 3 (Moderate strength)	19.75%	1.11 (0.95, 1.28)	0.182
Level 4 (Moderate-high strength)	19.44%	1.05 (0.94, 1.17)	0.412
Level 5 (High strength)	21.25%	1.13 (0.98, 1.31)	0.082
Time since legal sales began			
<1 Year	19.53%	Ref	Ref
1-3 Years	20.48%	1.02 (0.97, 1.07)	0.475
4+ Years	18.96%	0.84 (0.79, 0.90)	<0.001
Age			
16-20 years	28.11%	Ref	Ref
21-30 years	27.59%	0.77 (0.72, 0.82)	<0.001
31-50 years	20.12%	0.50 (0.46, 0.53)	<0.001
51-65 years	11.45%	0.26 (0.24, 0.27)	<0.001
Frequency of use			
Never consumer	16.47%	Ref	Ref
Consumed more than 12 months ago	18.69%	1.35 (1.30, 1.42)	<0.001
Past-12-month consumer	20.04%	1.24 (1.17, 1.32)	<0.001
Monthly to weekly consumer	21.45%	1.37 (1.30, 1.45)	<0.001
Daily Consumer	26.11%	1.74 (1.65, 1.82)	<0.001
Sex at birth			
Female	20.50%	1.07 (1.04, 1.11)	<0.001
Male	18.94%	Ref	Ref
Education			
Less than high school	22.55%	Ref	Ref

High school diploma or equivalent	20.65%	1.17 (1.08, 1.25)	<0.001
Some university/college	21.03%	1.37 (1.27, 1.47)	<0.001
Bachelor's degree or higher	17.10%	1.23 (1.14, 1.32)	<0.001
Ethnicity			
White (non-Hispanic)	18.65%	Ref	Ref
White (Hispanic)	24.48%	1.13 (1.08, 1.19)	<0.001
American Indian or Alaskan Native	23.12%	1.09 (0.97, 1.23)	0.167
Asian	15.92%	0.80 (0.73, 0.86)	<0.001
Black or African American	20.79%	0.95 (0.89, 1.00)	0.061
Native Hawaiian or Pacific Islander	26.17%	1.24 (1.00, 1.54)	0.047
Other/2+ races	25.63%	1.21 (1.12, 1.30)	<0.001
Unstated	19.82%	0.95 (0.85, 1.08)	0.441
Income adequacy			
Difficult or very difficult	22.88%	Ref	Ref
Neither easy nor difficult	19.23%	0.82 (0.79, 0.86)	<0.001
Easy or very easy	17.63%	0.78 (0.75, 0.81)	<0.001
Not Stated	13.29%	0.46 (0.41, 0.51)	<0.001
Variance of random intercept			
τ^2	0.0042		
VPC or ICC[a]	0.0013		

[a]VPC variance partition coefficient, ICC intraclass correlation coefficient

Table A20. Sample Characteristics: Gender

	Unweighted, n (%) n=185,388	**Weighted, n (%)** n=185,388
Gender		
Cisgender Woman	125905 (67.91%)	91126 (49.15%)
Cisgender Man	56351 (30.40%)	90424 (48.78%)
Transgender Woman	813 (0.44%)	1356 (0.73%)
Transgender Man	705(0.38%)	582 (0.31%)
Nonbinary[a]	177 (0.09%)	184 (0.10%)
Gender Diverse/Other	528 (0.28%)	563 (0.30%)
Unstated	916 (0.49%)	1153 (0.62%)

[a]Data only available from survey wave 6 (2023) onwards

Table A21. Noticing cannabis marketing by gender

	% Noticed
Gender	
Cisgender Woman	48.48%
Cisgender Man	54.99%
Transgender Woman	58.31%
Transgender Man	61.58%
Nonbinary[a]	72.94%
Gender Diverse/Other	60.39%
Unstated	44.76%

[a]Data only available from survey wave 6 (2023) onwards