



## Changes in online marketing and sales practices among non-medical cannabis retailers in 5 US cities, 2022 to 2023

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### ABSTRACT

**Objectives:** Given the evolving cannabis marketplace (e.g., products, marketing strategies), this study examined online cannabis marketing practices over time.

**Methods:** In 2022 and 2023, researchers assessed website content (e.g., age verification, sales, delivery, warnings, ad content, promotional strategies) among 175 randomly-selected cannabis retailers' websites across 5 US cities (Denver, Colorado; Seattle, Washington; Portland, Oregon; Las Vegas, Nevada; Los Angeles [LA], California, n=35/city). Analyses compared data from 2022 vs. 2023 and considered regulatory factors across cities.

**Results:** Similar to 2022, in 2023, 76.6 % required age verification for site entry, 85.1 % used social media promotion, and 90.9 % offered online sales (82.4 % of which required age verification and 34.6 % offered delivery). There were significant ( $p < .05$ ) decreases from 2022 to 2023 in the proportions indicating medical card requirements (27.4 % to 15.4 %), purchase limits (59.4 % to 47.4 %), health warnings (38.9 % to 29.7 %), health benefits (60 % to 47.4 %), and discounts/price promotions (92.6 % to 86.3 %). In 2023, proportions differed across cities in ways reflecting whether state/local law allowed online sales (>90 % in Denver, Las Vegas, LA), allowed discounts/price promotions (100 % in Denver and Las Vegas), or required health warnings (48–60 % in Seattle and LA vs. < 20 % elsewhere). Despite all sites prohibiting youth-oriented content and all but Denver and Las Vegas prohibiting health claims, 30.3 % posted content targeting youth/young adults (LA = 8.1 % to Denver = 74.2 %) and 47.4 % health claims (Seattle = 27.0 % to Denver = 71.0 %).

**Conclusions:** Online cannabis retail presents risks for access and appeal to minors, emphasizes health benefits, and uses price promotions, regardless of restrictions, indicating need for greater regulatory efforts.

### 1. Introduction

As of March 2024, 24 states, 2 US territories, and DC have legalized non-medical (i.e., recreational) cannabis use, despite remaining federally illegal (Center and Tobacco, 2023). Within this context, the cannabis market has grown substantially, as has its contribution to the US economy and tax revenues (Flowhub, 2024). Important to this growth has been cannabis industry marketing (e.g., product types; price;

promotions; advertising), which is a well-documented determinant of individual perceptions and use (Whitehill et al., 2020; Trangenstein et al., 2021; Trangenstein et al., 2019; Rup et al., 2020; Firth et al., 2022; Noël et al., 2021; Krauss et al., 2017; D'Amico et al., 2018; Tveleneva et al., 2022; Cohn et al., 2023; Ladegard et al., 2020; Wang et al., 2018). In addition to understanding how products are advertised, it is critical to assess the nature of cannabis products available, given their rapid diversification, as well as product price (Goodman et al., 2020), which

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impacts consumer behaviors (Faith, 2018), either by discouraging use via taxation (Boesen, 2023) or promoting use via discounts and promotions (Berg et al., 2018; Hoepfer et al., 2022).

Regulations regarding retail and marketing, which are important for protecting consumers, often differ across states (Ling et al., 2022; Weisz, 2022). States have varied restrictions on products (e.g., beverages, synthetic THC), amount of product sale (Weisz, 2022), discounts, (Barry and Glantz, 2016), marketing that target minors (<21 years old), use of false or misleading information, and/or unsubstantiated health claims (Weisz, 2022). Unfortunately, research has documented retailer non-compliance with such regulations, for example, by offering price promotions (Berg et al., 2018; Nicholas et al., 2021; Berg et al., 2017; Berg et al., 2023), promoting cannabis health benefits (Berg et al., 2023), and targeting youth by selling youth-appealing products (e.g., candy flavored products) (Lenk et al., 2021; Shi and Pacula, 2021). Age verification compliance studies have shown mixed findings: some studies reported high (83–100 %) compliance for purchases (Berg et al., 2018; Nicholas et al., 2021; Berg et al., 2017; Berg et al., 2023; Lenk et al., 2021; Shi and Pacula, 2021); however, a California-based study found that only 12 % of retailers checked ID before entry (Shi and Pacula, 2021).

Online cannabis retail is a critical component of the industry's activity. Retailers frequently use online channels and digital media to promote their business and products, facilitate online sales and deliver, and reach a broad range of consumers (Weisz, 2022). Although online cannabis retail is increasingly used (Ling et al., 2022; Bierut et al., 2017), relevant regulations are often non-existent, vague, or difficult to enforce, potentially increasing access for most consumers including youth (Ling et al., 2022).

Research focused on online cannabis retail practices is crucial to inform regulatory efforts (Berg et al., 2018; Nicholas et al., 2021; Berg et al., 2017; Berg et al., 2023; Lenk et al., 2021; Shi and Pacula, 2021). For example, US-based studies examining online cannabis retail in various states (Hoepfer et al., 2022; Ling et al., 2022; Bierut et al., 2017; Cavazos-Rehg et al., 2019; Luc et al., 2020; Forzley, 2021), on social media (Anderdal Bakken and Kirstine, 2023; Jenkins et al., 2021), and on cannabis-specific online platforms (Childs et al., 2022) have shown that cannabis promotion often emphasizes diverse health claims (e.g., managing pain, nausea/vomiting, anxiety, insomnia) and positive psychoactive effects (e.g., enhancing creativity and pleasure), and may appeal to minors, (Hoepfer et al., 2022; Bierut et al., 2017; Cavazos-Rehg et al., 2019; Luc et al., 2020) despite relevant state restrictions.

Notably, none of these studies examined changes over time, which is crucial to understand changes in the retail context as it grows and evolves (Grand View Research, 2023). Recent cannabis market reports indicated shifts in consumers (e.g., more adults trying cannabis, more women) and business leadership (i.e., more women and/or minorities) and reductions in cannabis prices (by 32 % since 2021), all of which could impact marketing and product types (Flowhub, 2024). Particularly relevant to the current study, cannabis buyers, especially frequent buyers, are increasingly preparing for a purchase by researching online (e.g., studying a local dispensary's menu, identifying discounts/price promotions) (Flowhub, 2024), making ongoing surveillance of retail websites crucial.

This study analyzed cannabis retail website data from the Cannabis Regulation, Marketing & Appeal (CARMA) study, which examines non-medical adult-use cannabis regulation and retail. The parent study involves annual surveillance of cannabis retail websites (Duan et al., 2023) (2022–2025) and in-person cannabis retail audits (Berg et al., 2023) and mystery shopper audits (Romm et al., 2024) at 2 timepoints (2022, 2025). Retail surveillance primarily focuses on 5 cities with the most established non-medical cannabis markets: Denver, Colorado (established in 2014); Seattle, Washington (2014); Portland, Oregon (2015); Las Vegas, Nevada (2017); and Los Angeles (LA), California (2018). Given the diversity and geographic spread of online cannabis retailers and the various state and local laws that could apply, the website audits

focused on websites from storefronts in these 5 cities in order to feasibly allow the consideration of state and local regulations and how the online context compares to the in-store experience. These websites likely target the local market, but are nonetheless available to all internet users.

Previously published findings from the 2022 website audits (Duan et al., 2023) and in-person retail (Berg et al., 2023) and mystery shopper audits (Romm et al., 2024) echoed findings from other studies (e.g., high rates of price promotions and health claims; few warnings) (Berg et al., 2023; Duan et al., 2023; Romm et al., 2024). Additionally, website audit data (Duan et al., 2023) showed mixed findings regarding whether retail activity by city reflected relevant state and local laws. (See Supplementary Table 1 for select state cannabis retail policies across these 5 cities.) For example, over half of Washington and Oregon retailers posted health claims despite state prohibition, price promotions were prevalent regardless of site-specific related restrictions (Washington, Oregon, California), and only 10 % had health warnings regarding use during pregnancy despite requirements in all 5 states (Duan et al., 2023).

Despite few changes in cannabis retail related regulations in these 5 sites from 2022 to 2023, the cannabis retail environment has likely changed, due to changes in the consumer base, industry leadership, product offerings, pricing strategies, and other factors (Flowhub, 2024). Given the evolving nature of the cannabis retail context – both irreplaceable and as a result of regulatory changes (Flowhub, 2024) – this study aimed to address the dearth of research systematically examining online cannabis marketing over time. We analyzed data from matched pairs of cannabis retail websites in 5 cities with legalized non-medical cannabis sales that were assessed in 2022 and 2023. Based on market research, (Flowhub, 2024) we hypothesized certain changes occurred, including increases in online sales and delivery, social media promotion, product diversity, and use of price promotions.

## 2. Methods

### 2.1. Website selection

This online website audit study was deemed exempt by the George Washington University Institutional Review Board. The sampling frame for websites assessed in 2022 is detailed elsewhere (Duan et al., 2023). In brief, we identified locations with non-medical cannabis retail licenses in these 5 cities in April 2022, using data from websites for their respective state cannabis regulatory agencies. Online searches and phone calls were conducted to verify whether the license referred to a brick-and-mortar storefront and had a website. Website audits were completed among a total of 195 websites (~40/city) in April-June 2022.

In April-June 2023, we revisited these same websites to determine if they were still active and met eligibility criteria (i.e., sold cannabis, connected to a cannabis retail storefront). In 2023, 89.7 % (n = 175 of 195 stores audited in 2022) were eligible. Of the 20 websites that were ineligible, the majority (n = 13) were inactive (others: not connected to storefront, n = 3; changed name, n = 1; replaced by new cannabis retailer, n = 3; see [Supplementary Figure 1](#) for flowchart). Those assessed in 2022 but ineligible for the 2023 follow-up (i.e., inactive, no storefront, changed name/ownership) were less likely to have online sales, offered fewer product types, and were less active on social media.

### 2.2. Data collection

#### 2.2.1. Training and quality control

The same methods were used in 2023 as in 2022 (reported previously<sup>36</sup>). Ten graduate research staff were trained to conduct assessments. To ensure protocol comprehension and application and assess initial inter-rater reliability, staff were divided into pairs and each pair coded 3 randomly-selected websites from the target sample. All discrepancies were identified, discussed, and reconciled in group meetings. Subsequently, all websites were dual-coded by staff pairs. Once data

collection began, staff met weekly to address data collection issues, ensure data quality, and discuss potential emergent themes. Initial kappa values exceeded .67 across items, with the vast majority exceeding .80 (substantial agreement) (McHugh, 2012) all discrepancies were rectified in group review to finalize the data

### 2.2.2. Assessment form

The assessment tool was adapted from prior measures assessing cannabis marketing, including online (Hoepfer et al., 2022; Bierut et al., 2017; Cavazos-Rehg et al., 2019) and at brick-and-mortar stores, (Berg et al., 2018; Berg et al., 2017) and has demonstrated high inter-rater reliability (Duan et al., 2023). See Supplementary Table 2 for detailed description.

**Retailer characteristics.** We assessed whether the website represented multiple locations (i.e., chain) and any indication regarding ownership (e.g., racial/ethnic minorities, LGBTQ + individuals).

**Age verification, online sales, delivery, and payment options.** We assessed age verification to access the website, availability of online sales, and forms of payment. Among those offering online sales, we assessed: 1) age verification for online purchases; and 2) delivery, and if so, delivery restrictions (i.e., location or distance restrictions).

**Restricted access and purchase limits.** We assessed whether the website indicated medical card requirements to access specific products for on-line purchase and/or restrictions on purchase amount.

**Health warning content.** We coded any health warnings (physical health, mental health; warnings for youth/young adults or pregnant/postpartum women).

**Products sold.** We assessed types of THC-containing products (e.g., flower/bud, edibles, vaporizers/vaping devices, concentrates, topicals, tinctures, and cannabis beverages), alternative products like Delta-8 THC, CBD-only products, other substances (e.g., kratom, alcohol), apparel, etc.

**Marketing strategies.** We assessed content (i.e., text, imagery) indicating health benefits (medical, mental health). We also coded content targeting/representing specific populations including youth/young adults, veterans, LGBTQ + individuals, and racial and ethnic minorities. As noted in Supplementary Table 2, these codes reflected images of people representing the respective groups, and symbols (e.g., candy for youth, rainbow flag for LGBTQ + ) or text (e.g., celebrating specific holidays) reflecting interests of these groups. The youth-oriented code drew upon definitions of youth-oriented advertising used in the state laws. Given that it is difficult to ascertain the age, sexual orientation, or race/ethnicity of individuals in photos, these codes were used with caution, and 'young adult' was added to the 'youth' code. We also coded content with key themes (party/cool/popularity imagery (Ling et al., 2022), celebrity/influencer endorsement (Leos-Toro et al., 2021), exclusivity/luxury imagery (Gilbert, 2021; Asquith, 2021), sexualized imagery (McCausland et al., 2020).

We also assessed indicators of: 1) price promotions (i.e., discounts, samples, and/or promotions; subscription/membership programs); 2) community engagement (i.e., activism for underrepresented groups or social causes, local event sponsorship, information/links to medical/mental health resources); and 3) other marketing channels used (e.g., social media, print/newspapers/magazines, radio/podcasts).

### 2.3. Data analysis

Analyses were conducted using SPSS v28.0 and STATA MP18.0, and significance was set at  $p < .05$ . First, we conducted descriptive analyses to characterize websites at the 2 timepoints. Next, to explore our primary research question regarding longitudinal changes on online cannabis retail practices, we conducted bivariate analyses examining overall differences in matched pairs between 2022 and 2023 (presented in Tables 1-3). Bivariate analyses used McNemar Tests for matched pairs, chi-square tests, and Fisher exact tests for cell sizes  $\leq 5$ .

The small sample size per city limited power for city-specific

**Table 1**

Retailer characteristics and factors related to age verification, sales, and delivery among cannabis retail websites in 5 US cities in 2022 and 2023 among matched pairs at each time point,  $N = 175$ .

	Year 2022	Year 2023	
Variables	N = 175 n (%)	N = 175 n (%)	p-value
<b>Retailer characteristics</b>			
Website represents multiple locations (e.g., chain)	75 (42.9)	82 (46.9)	.184
Ownership diversity/population representation			
White/Caucasian	21 (12.0)	17 (9.7)	.571
Underrepresented racial/ethnic groups	12 (6.9)	10 (5.7)	.774
Other underrepresented groups (LGBTQ+, veterans, etc.)	7 (4.0)	8 (4.6)	.999
Not indicated	135 (77.1)	144 (82.3)	.188
<b>Age verification, online sales, and delivery</b>			
Age verification to enter site	141 (80.6)	134 (76.6)	.230
Online sales available	165 (94.3)	159 (90.9)	.180
<i>Among websites offering online sales</i>			
Age verification to purchase online	138 (83.6)	131 (82.4)	.486
Age verification for pickup or delivery	95 (57.6)	62 (39.0)	<.001
Delivery available	52 (31.5)	55 (34.6)	.503
<b>Payment options</b>			
<i>Forms of payment accepted</i>			
Cash	142 (81.1)	145 (82.9)	.700
Debit	59 (33.7)	71 (40.6)	.045
Credit	10 (5.7)	20 (11.4)	.031
Mobile	7 (4.0)	8 (4.6)	.549
Not indicated	31 (17.7)	28 (16.0)	.690
Advertise access to ATM in store	58 (33.1)	68 (38.9)	.089

comparisons or examinations of change over time; however, we conducted exploratory analyses to examine: 1) differences across cities in 2023 (given the prior publication of the 2022 analysis by city<sup>36</sup>); and 2) differences in matched pairs between 2022 and 2023 for each city. To minimize reader burden, analyses examining differences across cities in 2023 are presented in Supplementary Tables 3-5, and notable findings from matched pairs analysis comparing 2022 and 2023 (which identified few differences) are indicated in text only. Findings by city – both at the 2023 cross-section and over time – were considered within the context of relevant site-specific state or local laws (see Supplementary Table 1) and noted accordingly in text.

## 3. Results

### 3.1. Age Verification, online sales, delivery, and payment options

In 2023, 76.6 % required age verification for site entry, and 90.9 % indicated online sales, of which, 82.4 % required age verification to purchase online, 34.6 % offered delivery, and 39.0 % required age verification for pickup or delivery (Table 1). There were no significant differences from 2022, except the proportion requiring age verification for pickup or delivery decreased (from 57.6 % in 2022,  $p < .001$ ). In 2023, 82.9 % accepted cash, 40.6 % debit cards (increased from 33.7 % in 2022,  $p = .045$ ), and 11.4 % credit cards (increased from 5.7 % in 2022,  $p = .031$ ; Table 1).

**Table 2**

Product access, health warnings, and product types sold among cannabis retail websites in 5 US cities in 2022 and 2023 among matched pairs at each time point, N = 175.

Variables	Year 2022	Year 2023	P-value
	N = 175 n (%)	N = 175 n (%)	
<b>Restricted access and purchase limits</b>			
Indicates medical card required for specific products	48 (27.4)	27 (15.4)	.002
Indicates restrictions on product amount purchased	104 (59.4)	83 (47.4)	.009
Includes links for how to get medical cannabis card	28 (16.0)	23 (13.1)	.332
<b>Health warning content</b>			
No health warnings found	107 (61.1)	123 (70.3)	.038
Any health warnings indicated	68 (38.9)	52 (29.7)	
Physical health only	37 (21.1)	23 (13.1)	
Mental health only	3 (1.7)	1 (0.6)	
Both medical and mental health	28 (16.0)	28 (16.0)	
Health warning content for specific populations			
Youth or young adults	16 (9.1)	18 (10.3)	.855
Pregnant or postpartum women	17 (9.7)	6 (3.4)	.019
<b>Products sold</b>			
<b>Cannabis product types</b>			
Flower	172 (98.3)	166 (94.9)	.070
Edibles	170 (97.1)	165 (94.3)	.180
Vaporizers/vaping devices	166 (94.9)	162 (92.6)	.424
Concentrates	170 (97.1)	163 (93.1)	.065
Topical/tincture	164 (93.7)	158 (90.3)	.210
Cannabis beverages	125 (71.4)	156 (89.1)	<.001
Delta-8	14 (8.0)	1 (0.6)	<.001
CBD-only products	78 (44.6)	73 (41.7)	.640
<b>Equipment for cannabis use</b>			
Vaping devices	151 (86.3)	158 (90.3)	.210
Bongs/pipes	102 (58.3)	116 (66.3)	.071
Rolling machines/rolling paper	119 (68.0)	127 (72.6)	.291
Apparel, hats, backpacks, etc.	72 (41.1)	82 (46.9)	.155

Notes: No retailers sold kratom; less than 2% sold alcohol.

In 2023, age verification for site entry or purchase did not differ across cities (Supplementary Table 3). However, proportions allowing online sales differed across cities reflecting whether state/local law allowed online sales (>90 % in Denver, Las Vegas, LA).

### 3.2. Restricted access and purchase limits

Shown in Table 2, from 2022 to 2023, the proportions of retailers decreased that indicated medical card requirements for specific products from 27.4 % to 15.4 % (p = .002) and purchase amount restrictions from 59.4 % to 47.4 % (p = .009). In 2023 (Supplementary Table 4), retailers across cities differed with regard to indicating medical card requirements (range: Seattle and LA = 2.7 % to Portland = 36.1 %) and purchase amount restrictions (range: LA = 21.6 % to Las Vegas = 67.6 %), despite relevant restrictions in each site.

### 3.3. Health warnings

There were decreases in the proportions of retailers showing any

**Table 3**

Marketing strategies among cannabis retail websites in 5 US cities among matched pairs at each time point, N = 175.

Variable	Year 2022	Year 2023	p-value
	N = 175 n (%)	N = 175 n (%)	
<b>Content claiming health benefits of cannabis use</b>			
No benefits indicated	70 (40.0)	92 (52.6)	.011
Any benefits indicated	105 (60.0)	83 (47.4)	
Medical benefits only	9 (5.1)	7 (4.0)	
Mental health benefits only	16 (9.1)	14 (8.0)	
Both medical and mental health benefits	80 (45.7)	62 (35.4)	
<b>Content targeting/representing specific populations</b>			
Youth or young adults	45 (25.7)	53 (30.3)	.358
Veterans	50 (28.6)	39 (22.3)	.118
LGBTQ+	10 (5.7)	10 (5.7)	.999
Racial/ethnic minorities	8 (4.6 %)	37 (21.1)	<.001
<b>Content themes</b>			
Party/cool/popularity imagery	51 (29.1)	62 (35.4)	.215
Celebrity/influencer endorsement	33 (18.9)	36 (20.6)	.755
Exclusivity/luxury imagery	10 (5.7)	66 (37.7)	<.001
Sexualized imagery	3 (1.7)	22 (12.6)	<.001
<b>Price promotions</b>			
Offer discounts, samples, or promotions	162 (92.6)	151 (86.3)	.035
Offer membership or loyalty programs	110 (62.9)	118 (67.4)	.268
<b>Community engagement</b>			
Activism for underrepresented groups or social causes	61 (34.9)	58 (33.1)	.775
Local event sponsorship	35 (20.0)	45 (25.7)	.212
Information/links to medical/mental health resources	45 (25.7)	6 (3.4)	<.001
<b>Other marketing channels</b>			
Any social media links	148 (84.6)	149 (85.1)	.999
Instagram	129 (73.7)	129 (73.7)	.999
Facebook	114 (65.1)	110 (62.9)	.617
Twitter	99 (56.6)	92 (52.6)	.281
Other*	53 (30.3)	51 (29.1)	.868
Print/newspapers/magazines	11 (6.3)	6 (3.4)	.125
Radio/podcasts	3 (1.7)	1 (0.6)	.500

Notes: \*Other included: YouTube, Yelp, LinkedIn, Pinterest, Leafly, Snapchat, TikTok, Weedmaps, Tumblr, Google, etc.

health warnings from 38.9 % in 2022 to 29.7 % in 2023 (p = .038) and health warning content for pregnant or postpartum women from 9.7 % to 3.4 % (p = .019; Table 2). In 2023 (Supplemental Table 4), proportions differed across cities reflecting whether state/local law required health warnings (48.6 % in LA and 59.5 % in Seattle vs. < 20 % elsewhere).

### 3.4. Product types

Almost all retailers (>90 %) sold flower, edibles, vaporizers, concentrates, and topicals/tinctures, while less than half (41–45 %) sold CBD-only products across timepoints (Table 2). The proportion selling



cannabis beverages increased from 71.4 % to 89.1 % ( $p < .001$ ), while there was a decrease for Delta-8 THC from 8.0 % to 0.6 % ( $p < .001$ ).

In 2023 (Supplemental Table 4), CBD-only product availability varied across cities (range: LA = 13.5 % to Las Vegas = 73.5 %), despite no restrictions in any site. In Los Angeles (LA), where Delta-8 and similar hemp-derived products are regulated like other cannabis products, the proportion of retailers selling these products decreased from 21.6 % to 2.7 % (data not shown in tables). Conversely, in other locations where these products were banned, <10 % sold them in 2022, and by 2023, none did.

### 3.5. Content themes

There were decreases in the proportion of retailers indicating any health benefits from 60 % in 2022 to 47.4 % in 2023 ( $p = .011$ ). Across timepoints, similar proportions of retailers had website imagery targeting teens or young adults (25.7 %-30.3 %), veterans (22.3 %-28.6 %), and LGBTQ + individuals (5.7 %), but there were increases in the proportions with imagery targeting racial/ethnic minorities (from 4.6 % to 21.1 %,  $p < .001$ ), content emphasizing exclusivity/luxury (from 5.7 % to 37.7 %,  $p < .001$ ), and content with sexualized imagery (1.7 % to 12.6 %,  $p < .001$ ).

Despite all sites prohibiting youth-oriented content and all but Denver and Las Vegas prohibiting health claims, 30.3 % posted content targeting youth/young adults (range: LA = 8.1 % to Denver = 74.2 %) and 47.4 % health claims (range: Seattle = 27.0 % to Denver = 71.0 %; Supplementary Table 5). Retailers across cities also differed in the proportions with content targeting veterans (range: Portland = 8.3 % to Las Vegas = 44.1 %), LGBTQ + individuals (range: Seattle = 0 % to Denver = 22.6 %), and racial/ethnic minorities (range: Seattle = 5.4 % to Las Vegas = 47.1 %).

### 3.6. Price promotions

At both timepoints, ~65 % offered membership or loyalty programs, and the proportion that offered discounts, samples, or promotions decreased from 92.6 % to 86.3 % ( $p = .035$ ; Table 3). In 2023, cities differed in ways reflecting state/local laws (i.e., only Colorado and Nevada allow discounts/price promotions; Supplementary Table 5). All Denver and Las Vegas retailers offered discounts, samples, or promotions (vs. elsewhere: 69.4 % [Portland] to 86.5 % [Seattle]) and 88.2 % in Las Vegas and 83.9 % in Denver offered membership or loyalty programs (vs. elsewhere: 36.1 % [Portland] to 70.3 % [LA]).

### 3.7. Community engagement and other marketing channels

In 2022 and 2023, similar proportions on websites engaged in activism for underrepresented groups or social causes (about one-third) and local event sponsorship (20–26 %). However, the proportion providing information/links to medical/mental health resources decreased from 25.7 % in 2022 to 3.4 % in 2023 ( $p < .001$ ). Social media was highly used at both timepoints (~85 %), particularly Instagram (~74 %) and Facebook (~65 %). Cities differed in their overall use of social media (range: Portland = 69.4 % to LA = 94.6 %; Supplementary Table 5), despite no specific restrictions on social media use in these sites.

## 4. Discussion

This study examined changes in online cannabis retail from 2022 to 2023 among websites of 175 cannabis retailers across 5 US cities, given the ongoing evolution of the cannabis market (Flowhub, 2024) and concerns regarding regulatory compliance. Roughly consistent across timepoints, one-fourth lacked age verification for site entry, and ~90 % offered online sales. Among those with online sales, one-fifth lacked age verification procedures at point-of-purchase, and one-third offered

delivery. These rates are higher than those documented in audits of brick-and-mortar stores (10 % lacked age verification, 25 % offered delivery) (Berg et al., 2023). Given that only ~5 % of our original list of retailers lacked associated websites, these findings suggest the importance of integrated surveillance of both brick-and-mortar stores and their websites, which show evidence of different approaches (Cavazos-Rehg et al., 2019). Furthermore, at both timepoints, ~85 % used social media, which is concerning given the high reach (including to those underage) and loopholes in social media policies prohibiting paid cannabis advertising (Ling et al., 2022). Also interesting, retailers assessed in 2022 but lost to follow-up in 2023 were less likely to have online sales and less active on social media, suggesting the importance of these activities for retailer success. Although rates of online sales or delivery and use of social media did not increase, this was likely due to the already high rates in 2022 (i.e., ceiling effect). Taken together, the high rates of use of social media, online sales, and delivery (especially without clear age verification procedures) raise concerns regarding underage access (Gaiha et al., 2020) and emphasize the need for regulations that prohibit online sales and delivery.

Several retail practices showed change over the one-year period, although the reasons for such changes are unclear (e.g., maturation effects, simple variation over time, meaningful change). Nonetheless, these changes warrant consideration. The proportion of websites showing health warnings decreased over time (38.9 % to 29.7 %), which is concerning given that each of these states mandates specific warnings at the point-of-sale. Another significant concern is that the proportion posting health warning content for pregnant or postpartum women decreased from 10 % in 2022 to 3 % in 2023, despite requirements for such warnings at the point-of-sale in all 5 states. Furthermore, there were decreases in the proportions indicating medical card requirements (27 % to 15 %) and purchase limits (59 % to 47 %). Although unclear, it is possible that retailers believe that consumer knowledge about these regulations increased and, thus, such signage was seemingly unnecessary. However, indicating medical card requirements was most prevalent in Denver, which has the longest-standing cannabis market, suggesting other reasons may underly this decrease. Additionally, posting purchase limits was most common in Las Vegas, the only city in a state that has this required signage in brick-and-mortar stores. These findings underscore the need for research to determine the reasons for noncompliance and the impact of such signage, given the mixed evidence for such regulatory (Britt et al., 2006; Wolfson et al., 1996; Forster et al., 1994) and health warning signage (Budenz et al., 2022; Wolfson and Poole, 2023; Coady et al., 2013).

Across retailers, a wide variety of products were sold at both timepoints, and those lost to follow-up offered less product variety, potentially suggesting the importance of variety to consumers (Shi et al., Dec, 2019; Zhu et al., 2020). Most retailers also sold products to facilitate cannabis use (e.g., vaporizers), and nearly half sold CBD-only products. However, few sold products like as Delta-8 THC (which reduced from 2022 to 2023); these findings may reflect increasing awareness and regulation of these products, as 4 of the 5 states implemented their Delta-8 bans in 2021 or 2022 (News, 2023).

Regarding promotional content, while the proportion indicating health benefits decreased, nearly half posted health benefits in 2023, which may reflect an underestimation of health claims conveyed at points-of-sale, as suggested by mystery shopper studies (Berg et al., 2021; Dickson et al., 2018). Across timepoints, ~25–30 % had imagery targeting youth/young adults, similar to rates documented in brick-and-mortar audits (Berg et al., 2023). These issues were most represented in Denver, despite Colorado's regulatory language being similar to the other 4 states. At both timepoints, few retailers (~5%) showed evidence of targeting LGBTQ + individuals. However, there were increases in the proportions targeting racial/ethnic minorities (>20 % in 2023), most commonly in Las Vegas, which has greater racial/ethnic diversity than the other cities except LA (Niche, 2023). Additionally, there were increases in content emphasizing exclusivity/luxury or sexuality, which

may appeal to specific populations (e.g., young people) (Hoepfer et al., 2022; MacKillop and Prioritizing, 2018; Fiala et al., 2018; Berg et al., 2018). Interestingly, compared to rates documented at brick-and-mortar stores (~3%), (Berg et al., 2023) a higher proportion (~25 %) targeted veterans, most commonly in Las Vegas which resides in a state with high representation of military and veterans (US News World Report, 2023).

Across both timepoints, ~65 % offered membership/loyalty programs, and > 85 % offered discounts, samples, or promotions in 2023, despite unexpected decreases from 2022. Notably, these strategies were used most commonly in Denver and Las Vegas, where there are no restrictions. These findings echo prior findings showing the prevalent use of price promotions (Berg et al., 2017; Buller et al., Nov, 2016; Cavazos-Rehg et al., 2019) and underscore the need to monitor these practices, given their impact on use, (Wang et al., 2022; Choi et al., 2019) particularly among more price-sensitive subpopulations (e.g., young adults, lower-income individuals) (Liber et al., 2022).

#### 4.1. Limitations

Findings have limited generalizability given that this sample of 175 websites represented only 5 cities in 5 states and excluded other types of retailers, such as home delivery services or websites without a storefront. This was chosen to feasibly allow the consideration of state and local regulations and for other analyses to compare the online versus in-store context. Other studies are needed to assess the broader range of online cannabis retail activities, as well as their impact on consumers. The sample size also restricted power for certain analyses, such as comparisons over time within cities and assessments of compliance, particularly when regulations varied between states. Additionally, given the relatively short (one-year) time-period between assessments and unknown reasons for documented changes (e.g., maturation, simple variation, meaningful changes), additional research examining longer-term trends and potential mechanisms of change are needed to support assertions regarding regulatory implications. Finally, the assessment tool requires ongoing revision to enhance its utility and remain relevant to the changing cannabis market.

#### 4.2. Conclusions

This study offers an important perspective on online cannabis retail practices and marketing strategies. Findings highlight notable lapses in regulatory compliance, especially in terms of accessibility (like age verification, and online sales and delivery), as well as the presence of regulatory and health warning signage. Additionally, the study revealed evidence of targeting specific subpopulations (such as young people and veterans) and the promotion of health benefits. In conclusion, these findings underscore the need for ongoing surveillance of online cannabis retail over a longer time-period, more precise regulatory language, and enhanced enforcement.

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Conceptualization. **Katelyn F. Romm:** Writing – review & editing, Methodology, Investigation, Conceptualization. **Yan Wang:** Writing – review & editing, Methodology, Investigation, Conceptualization. **Patricia A. Cavazos-Rehg:** Writing – review & editing, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Erin Kasson:** Writing – review & editing, Methodology, Investigation, Conceptualization. **Y. Tony Yang:** Writing – review & editing, Conceptualization. **Carla J. Berg:** Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Conceptualization.

#### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

#### Data availability

Data will be made available on request.

#### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.pmedr.2024.102755>.

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