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Exploratory analysis of United States-based cannabis product health benefit claims on online marketplaces

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Abstract

Background and aims: Cannabis-derived products (CDPs), including cannabidiol (CBD) and tetrahydrocannabinol (THC) products, are widely diverse and readily available through physical and online retail channels in the United States (US) marketplace and may also include claims of treating or providing benefit for health issues. This study aimed to systematically classify the various types of health benefit claim(s) present on CDP listings based on publicly available online marketplace data.

Design: Exploratory analysis to identify health benefit claims.

Setting and cases: A total of 624 805 unique CDPs sold in the US on Leafly and Weedmaps, cannabis online marketplace service platforms.

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AUTHOR CONTRIBUTIONS

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DECLARATION OF INTERESTS

M.N., M.Z.L., Z.L., J.L. and T.K.M. are employees of the startup company S-3 Research. S-3 Research is a minority owned small business that was originally created through a National Institute on Drug Abuse startup business award and has been subsequently funded through government contracts with Federal agencies to develop research tools and services for data science in public health, including social listening, data mining and machine learning approaches. The company has contractual arrangements with federal agencies to conduct research on cannabis products. Authors report no other conflict of interests associated with this manuscript.

Measurements: This exploratory study was conducted in four phases: (1) data mining of cannabis e-commerce websites Weedmaps and Leafly for product listings in the US; (2) data filtering, text matching and content coding to identify types of advertised health benefit(s) made; (3) analysis on consumer-generated product reviews for sentiment toward advertised health benefit(s); and (4) ANOVA was used to test differences in mean number of health benefit claims based on product characteristic of route-of-administration (RoA).

Findings: A total of 624 805 unique US CDP sales listings from Leafly ($n = 50\,951$) and Weedmaps ($n = 573\,854$) were analyzed. CDP listings with a specific health benefit claim(s) were detected in 998 (1.9%) Leafly and 25 671 (4.47%) Weedmaps CDP listings. The top 5 advertised health benefits were treatment of mood disorders, general discomfort, general wellness, sleep disorders and chronic conditions. Among consumer reviews, 295 (4.6% of consumer reviews from products that advertised health benefit(s)) expressed sentiment toward CDP addressing their health issue with 82.4% being positive, 14.6% negative and 3.1% neutral. We also observed statistically significant differences between RoA and frequency of health benefit claims among those with at least one health benefit claim, with multisystem products (>1 RoA) generally having a higher number of average health benefit claims compared with other RoAs.

Conclusions: Over 26 000 cannabis-derived products listed on two popular US cannabis online marketplaces have at least one health benefit claim.

Keywords

cannabis; cannabis derived products; cannabis industry; cannabis marketing; e-commerce; marijuana

INTRODUCTION

The United States (US) legal cannabis industry is estimated to grow to \$50.7 billion by 2028 as legalization of medical and non-medical adult cannabis use expands across US states [1]. Cannabis, commonly known as marijuana, refers to the dried flowers, leaves, stems and seeds of the cannabis plant [2]. Importantly, the US Federal Control Substance Act (CSA) definition of marijuana excludes products that meet the legal definition of hemp [cannabis plants and derivatives containing no more than 0.3% Δ -9 tetrahydrocannabinol (THC) on a dry weight basis per the US Agriculture Improvement Act of 2018].

The US National Survey on Drug Use and Health reported in 2023 that 61.8 million individuals age 12 years or older reported using marijuana (including cannabinoid chemical substances and THC, the psychoactive components of cannabis), making it the most commonly used psychoactive substance other than alcohol [2, 3]. Increasing cannabis use is driven by multiple factors, for instance, widespread product marketing online and in physical spaces, with advertisement exposure associated with higher odds of marijuana use, heavier use and use of novel products with higher THC concentrations [4–7].

Direct-to-consumer cannabis online marketplaces, that aggregate products sold through physical and online retailers, facilitate the sale of naturally occurring cannabinoids and cannabis-derived product (CDP) [generally defined as products with compounds occurring naturally in the *Cannabis sativa* L. plant, including cannabidiol (CBD) and THC], which

are the focus of this study [8]. These platforms provide consumers with access to a diverse selection of CDPs helping consumers find cannabis vendors/dispensaries and facilitating online shopping options (e.g. in some states online ordering via delivery, pickup). Two large cannabis marketplaces are Leafly (a website with more than 100 million visitors per year) and Weedmaps (a web and mobile-based platform with 17.4 million monthly active users in 2022) [9–11]. CDP listings on these marketplaces can also include descriptions that products treat certain health ailments, conditions and even specific diseases [12].

Prior research has examined different online sources purporting health benefits of CDPs (e.g. Internet articles, social media posts) and also on websites operated by cannabis dispensaries [13–15]. These studies found a number of health- or disease-related marketing claims including for treatment of pain, spasms, anxiety, depression, insomnia and nausea/vomiting to name a few [13]. Importantly, marketing of unsubstantiated health claims can introduce unique public health, social justice and consumer protection issues, including targeted marketing toward certain minorities that could lead to unequal distribution of health impacts of cannabis use [13, 16]. Prior studies specifically conducting analysis on Leafly and Weedmaps have characterized product marketing practices in specific US states and Canada, use of age verification and product pricing data [16–22]. One study of Weedmap found a high percentage of retailers in Colorado (61%) and Washington (44%) that made health benefit claims for CDPs [16].

Despite an increasing number of studies examining the potential health benefits of CDPs on conditions such as pain management, sleep disorders and harm reduction for specific substance use behavior [23–28], there are several known health harms and adverse events associated with acute consumption and chronic cannabis use (e.g. gastrointestinal, cardiovascular, cognition, mood and anxiety disorders and specific conditions such as cannabis hyperemesis syndrome). [29–33] Hence, to better understand the potential consumer and public health implications of direct-to-consumer marketing of health benefit claims, we conducted an exploratory observational study of Leafly and Weedmaps with the aim of detecting and characterizing CDP health benefit claims sold in the United States.

METHODS

This exploratory study was conducted in four phases: (1) data mining of all cannabis product listings (including extracted and synthesized CDPs and naturally occurring and grown cannabis products) located in the United States on cannabis online marketplaces, Leafly and Weedmaps (chosen as they are two large cannabis websites); (2) keyword filtering of product listings using a set of health- and medical-related terms to identify the health benefits listed in product descriptions; (3) manual annotation and content analysis to conduct in-depth characterization of advertised health benefits; and (4) examined health benefit claims to better understand any statistical differences by examining product characteristics and location of product purchases. See Figure 1 for summary.

This study was exempt from institutional review board approval in accordance with the Common Rule, as all data were publicly available and any user-generated data did not include individually identifiable information, and results are presented in the aggregate.

The study followed the Standards for Reporting Qualitative Research (SRQR) reporting guideline.

Data collection and content coding

Market surveillance on Leafly used a custom data mining program developed in Python 3.7.4 and Selenium 4.4.3. Another customized data mining tool was also developed in Python and the package Beautiful Soup 4.6.0 for Weedmaps that used a map-based grid search dividing the United States into three main regions: the contiguous United States, Alaska and Hawaii. For each region, we performed an individual grid search. Address of vendors for CDP listings were geocoded and aggregated to the state level to summarize location.

Keywords generation and content analysis

We conducted data mining and in-depth manual content coding for all product listings to identify and characterize CDP-related health benefit claims. Manual annotation was first applied to all Leafly data collected to generate an initial signal dataset (i.e. signal here is defined as CDP listings including a health benefit-related description, ‘Round One’ of Figure 1) because of the smaller volume of data compared to Weedmaps. Next, we cataloged all relevant health benefit description keywords and categorized them into general health benefit descriptions (e.g. general pain, headache, etc.), undifferentiated health symptoms (e.g. inflammation, anxiety, etc.) and specific disease benefits (e.g. cancer, colitis, etc.). Using these keywords, an initial codebook was created for data mining and filtering of the larger corpus of Weedmaps data (Supporting information). This initial set of keywords was used to filter the full corpus of Weedmaps’ ‘product description’ category to detect similar health benefit descriptions and to identify additional health benefit descriptions that co-occurred in newly detected product listings (‘Round Two’). This process was repeated a third time, similar to a snowball sampling strategy, but applied to any new health benefit description keywords detected, until we achieved thematic saturation where no additional new health benefit description themes were readily observed (‘Round Three’). Two coders (first and second authors) coded the entire unlabeled dataset independently and achieved a high intercoder reliability ($\kappa = 0.96$). In case of inconsistent results, authors reviewed and conferred on the correct classification with senior author (last author) to achieve consensus.

An inductive coding schema was applied to all CDP listings that met the inclusion criteria of having at least one health benefit claim. Each detected health benefit claim was then categorized into a parent class (i.e. broad categories of health, medical or disease conditions) and then sub-parent class (i.e. specific health, medical and disease categories within general parent categories) informed by standardized medical terminology in MedDRA (v28.0). A single CDP listing could have multiple health benefit claims with one parent and one sub-parent class. Additional inductive coding was used to categorize CDPs into specific product characteristics based on a published CDP taxonomy by Nali *et al.* [34], which included route of administration (RoA) and whether they included a health disclosure or product warning [e.g. not to be used while pregnant, has not been tested or evaluated by the US Food and Drug Administration (FDA), may cause cancer]. CDP listings that had at least one claim were categorized into specific RoAs including: multi-system (i.e. considered multi-system

based on common consumer consumption practices even when not explicitly labeled for such uses; e.g. products like ‘flower’ or ‘seeds’ are categorized as multi-system because of their typical and feasible methods of use, such as smoking or being edible), respiratory (i.e. products inhaled, smoked, vaporized), digestive (i.e. products consumed through eating or drinking) and epidermal (i.e. products applied directly to the skin). Finally, customer reviews of product listings with at least one health benefit were manually coded for self-reported sentiment (positive, negative, neutral) regarding their experience with a health benefit.

We also developed a data taxonomy to create an automated text matching process in Python (Version 3.8) to match CDP listings to their respective health benefit claims and product characteristics (Supporting information).

Statistical analysis

As this study was exploratory, we sought to assess whether the way a cannabis product was administered (i.e. RoA) was associated with the number of health benefit claims made. RoA as a variable of measurement was chosen on the basis of existing literature, including a National Academies of Sciences, Engineering and Medicine (NASEM) report that notes that cannabis can be administered in many ways, and that depending on the RoA, active compounds may get to the bloodstream faster, which could have implications for perceived health benefit or therapeutic effect made in a health benefit claim observed [29, 30]. Additionally, as cannabinoid compounds (e.g. cannabidiols, Cannabigerols, Δ -8-tetrahydrocannabinols, etc.) or potency (e.g. % THC) associated with a product was not standardized, we were unable to use this product characteristic as a variable of measurement. Python (version 3.8) was used to conduct a one-way analysis of variance (ANOVA) comparing differences in the mean number of health benefit claims per product listing across RoA using the package statsmodels (version 0.14.1). Using the python package scipy. Stats (version 1.12.0), a Tukey honest significant difference (HSD) *post hoc* comparison was conducted to specify which RoA differed significantly in the mean number of health benefit claims made. We conducted an additional one-way ANOVA test to compare differences in the mean number of health benefit claims per product across each parent class category. A Tukey HSD *post hoc* comparison was conducted to specify how each parent category differed across the mean number of descriptions made. A *P*-value of <0.05 was considered significant.

RESULTS

A total of 1 463 510 CDP listings were collected on both Leafly and Weedmaps. After the removal of duplicate product listings with the same product ID, 624805 (42.7% of the original dataset) unique CDP remained; specifically, 50 951 (8.1%) from Leafly and 573 854 (91.9%) from Weedmaps. After keyword filtering and manual annotation of all unique CDP on Leafly and Weedmaps, 26 669 CDP (4.3% of total unique CDP listings; 2.0% of total Leafly listings; and 4.5% of total Weedmaps listing) were linked to at least one health benefit claim, comprised of 3.7% ($n = 998$) originating from Leafly listings and 96.2% ($n = 25 671$) from Weedmaps listings.

Across all Leafly listings reviewed with at least one claim ($n = 998$), we observed a mean of 3.4 health benefit claims per CDP listing. Of these 3.1% ($n = 31$) included some form of health warning or disclosure in their product information. For CDPs with at least one health claim on Weedmaps, a mean of 3.6 health benefit claims per CDP listing, with 0.8% ($n = 196$) having a health warning or disclosure were identified (see Table 1 for examples). Further, although cannabinoid compounds associated with a product were not standardized in CDP listing data, a summary of the breakdown per product listing observed and number of health benefit claims is provided in the Supporting information.

An analysis of all CDP listings on Leafly and Weedmaps with health benefit claims ($n = 26\,669$) revealed that 4.9% ($n = 1304$) of these listings received at least one user-generated product review, from which a total of 6458 individual reviews were collected. Of these reviews, 4.6% ($n = 295$) included a user mentioning their general sentiment toward the health benefit claim(s) made by that product (e.g. agreeing or disagreeing that the CDP helped address the health issue/claim). Of reviews expressing user sentiment, 82.4% ($n = 243$) included positive sentiment toward the product with the health benefit claim, 14.6% ($n = 43$) included negative sentiment and 3.0% ($n = 9$) included neutral sentiment.

Health benefit claims

From all 26 669 unique CDP listings on Leafly and Weedmaps with at least one health benefit claim, there were 96 054 total individual claims (e.g. treatment of HIV, breast cancer) mapped to 76 683 claims for sub-classes (e.g. viral infection, cancer) that represented 50 820 claims for parent classes (e.g. infectious disease, non-communicable disease). Note that one CDP listing could include multiple health benefit claims per listing.

A total of 1679 parent class claims came from Leafly (see Figure 2) and 49 141 from Weedmaps (see Figure 3). Overall, the five parent classes ranked based on frequency included: (1) general discomfort, health, wellness and nutrition or chronic conditions ($n = 23\,477$, 46.2%); (2) psychiatric disorder or central nervous system (CNS) conditions ($n = 20\,548$, 40.4%); (3) non-communicable disease conditions ($n = 6197$, 12.2%); (4) infectious disease conditions ($n = 366$, 0.7%); and (5) reproductive health conditions ($n = 232$, 0.5%).

The five parent classes were then broken down into 25 sub-parent classes with the top five most frequent sub-parent classes based on frequency including: (1) mood disorder ($n = 15\,409$, 20.1%); (2) general discomfort ($n = 14\,557$, 18.9%); (3) general wellness ($n = 13\,990$, 18.2%); (4) sleep disorders ($n = 7805$, 10.2%); and (5) and chronic conditions ($n = 6602$, 8.6%).

Further characterization was conducted and identified 149 disease- and condition-specific claims from the different sub-parent classes resulting in 96 054 total individual claims for these diseases and conditions (i.e. includes the total number of claims, including products with multiple individual claims). Notably, treatment of general pain (parent class: general discomfort, health, wellness and nutrition or chronic condition, $n = 10\,647$, 11.1%) was the most frequent health benefit claim. The second most common claim was part of the psychiatric disorder or CNS parent class; specifically, treating anxiety ($n = 9959$, 10.4%). Within the non-communicable disease parent class, health benefit claims

pertaining to inflammation ($n = 2072$, 2.2%) was most frequent. The top claim within the infectious diseases parent class was sexually transmitted infections/sexually transmitted disease (STI/STD) ($n = 165$, 0.3%). Finally, in the reproductive health parent class, benefits of cannabis to treat women's reproductive health (e.g. addressing menstruation discomfort or dysmenorrhea) were highest ($n = 125$, 0.1%).

Location of claims

Analysis was undertaken to determine the location of cannabis dispensaries with CDPs that made health benefit claims within the United States for Weedmaps, although location data for Leafly product listings was not retrievable (see Supporting information). Of the 25 671 CDPs with health benefit claims, a subset ($n = 19\ 205$, 74.8%) were successfully linked to retailers/dispensaries and identified as sold in 30 different US states. We further stratified these data based on the state-wide legal status of cannabis use: states where medical and non-medical cannabis use is legal ($n = 15\ 328$, 79.8%) and states that only allow medical cannabis use ($n = 3877$, 20.2%). No product listings were detected in states that prohibited medical and non-medical adult cannabis use. Overall, the top three states who permit legal cannabis use for both medical and non-medical purposes and had CDPs with a health benefit claim were Michigan ($n = 3040$, 19.8%), followed by California ($n = 2885$, 18.8%) and Missouri ($n = 2878$, 18.8%). The top three medical-only states were Oklahoma ($n = 1154$, 29.8%), followed by Arkansas ($n = 1039$, 26.8%) and Mississippi ($n = 638$, 16.5%) (See Figure 4 and Table S1).

Health benefit claims and route of administration

CDP listings that had at least one claim had the following frequencies by RoA categories: multi-system ($n = 12\ 499$, 46.9%), respiratory ($n = 9794$, 36.7%), digestive ($n = 2613$, 9.8%) and epidermal ($n = 1764$, 6.6%).

For Leafly, we found a statistically significant difference in the frequency of health benefit claims across RoA for CDPs with at least one health benefit claim ($F = 7.6_{3,994}$, $P < 0.001$, $\omega^2 = 0.019$). Leafly product listings with a multi-system RoA had, on average, more health benefit claims than those that were used via digestive ($P < 0.0021$) and epidermal ($P = 0.001$). Products with a respiratory RoA had, on average more health benefit claims than digestive ($P = 0.041$) and epidermal ($P = 0.018$).

For Weedmaps, we also found a statistically significant difference in the frequency of health benefit claims across RoA ($F = 190.9_{4,4985}$, $P < 0.001$, $\omega^2 = 0.022$). Similar to results from Leafly, Weedmaps product listings with a multi-system RoA had on average higher numbers of health benefit claims than respiratory ($P < 0.001$), digestive ($P < 0.001$) and epidermal ($P < 0.001$). Similarly, respiratory RoA had, on average, more health benefit claims than those for epidermal ($P < 0.001$) and digestive ($P < 0.001$) (see Supporting information Tables S1–S4).

DISCUSSION

This exploratory study conducted market surveillance of two popular cannabis online marketplaces used by millions of Americans and found 4.47% ($n = 26\ 669$) of CDP listings

had at least one health benefit claim (with a mean of 3.4 and 3.6 claims per product with at least one health benefit claim for Leafly and Weedmaps, respectively). The descriptions analyzed included purported benefits for serious, complex and life-threatening diseases such as cancer, mental health disorders, autoimmune diseases, neurological disorders and non-communicable diseases that require careful clinical management with a healthcare provider. The distribution of claims was higher in states where medical and non-medical cannabis use was legal (79.8%) compared to states that only allowed medical cannabis use (20.2%). These products encompassed 96 054 distinct individual health benefit claims across all CDPs reviewed, with the majority of user reviews interacting with these products having positive sentiment toward the health claim topic.

Currently, the FDA has only approved one CDP (Epidiolex) and three synthetic cannabis-related drug products (Marinol, Syndros and Cesamet) for limited therapeutic use [31]. Hence, the marketing of health benefits for adult recreational use cannabis on e-commerce platforms may influence consumer attitudes on CDPs as an alternative treatment or disease management method despite lack of FDA approval or competent and reliable scientific evidence to support claims. This may lead to consumers foregoing evidence-based care in favor of experimenting with cannabis, or may complicate existing treatment and care plans, particularly if a patient's cannabis use behavior is not discussed because of perceived stigma with a care provider [32, 33, 35, 36].

Further, only a small percentage of CDP listings with health benefit claims had product warnings or disclaimers. An overall lack of product warnings or disclaimers was observed despite passage of state laws requiring specified warnings about the safety of cannabis use on packaging and separate research indicating that health warnings are an important strategy to communicate risks to consumers (e.g. risks associated with addiction, impaired driving, worsening mental health, cannabis use disorder, use while pregnant or breastfeeding, etc.) [37]. Additionally, although not formally coded, we generally observed other CDP marketing characteristics coinciding with health benefit claims that included appealing marketing cues, such as attractive product marketing and packaging, flavoring and concurrent offers for sales promotions that may also impact consumer behavior.

Similar to prior studies examining cannabis health benefits made on different online platforms, we observed a large diversity of claims that spanned a host of general health areas, therapeutic topics and specific diseases [16, 17, 20]. We also observed statistically significant differences between RoA and frequency of health benefit claims among CDPs with at least one health benefit claim. Specifically, multi-system RoA CDPs were observed as having a higher frequency of claims compared to certain other RoAs in both the Weedmaps and Leafly datasets. These results need further study, as CDPs that can be consumed in multiple ways may lead to consumers being influenced by health benefit claims in how they use a cannabis product, which can impact how cannabis and its psychoactive components are absorbed in the bloodstream and its intoxicating effects (e.g. respiratory versus digestion). Additional research is needed to better understand how combinations of different health benefit claims (e.g. a product claiming to treat anxiety, cancer and a gastrointestinal disorder), their RoAs and other product characteristics (e.g. specific

cannabinoid compounds) have potential to elevate risk, such as through counterindications with existing treatment or negative changes in health behaviors.

Limitations

This study has several limitations. Data collection relied on custom programming applications, which may have limited completeness of product listings retrieved. The use of keyword filtering may not be comprehensive of all types of health benefit claims, particularly because we used an initial set of keywords identified from Leafly to filter for additional product listings on Weedmaps that might have not included new or unobserved health benefits claims. The rationale for this approach was to minimize the need for full manual annotation of all product listings because of the large size of the dataset and because of our initial experimentation with natural language processing approaches that did not yield topic groupings indicative of health benefit-related content. Results have limited generalizability, as data was only derived from two marketplaces for the purposes of conducting exploratory analysis of a select group of retailers that actively market CDPs using online services (i.e. may not include cannabis retailers that operate their own websites or are primarily brick-and-mortar). Additionally, we were unable to conduct robust statistical comparisons of health benefit claims based on types of cannabis compounds (e.g. CBD, Δ -8 THC, etc.) because of lack of standardization of product descriptions and inconsistency of terminology across product listings. Lack of standardization of CDP descriptors has also been highlighted as a challenge in another market surveillance study [34]. Finally, user-generated review data may also be biased toward users with stronger sentiment toward CDPs or their purported health benefits.

CONCLUSIONS

To our knowledge, this is the first study to comprehensively characterize CDP-related health benefit claims from two major nationwide online marketplaces. Most US states that allow adult-use have regulations concerning cannabis advertising and marketing, including some that prohibit claims that cannabis has therapeutic or curative benefit [38]. Reflecting ongoing concerns about CDP-associated unsubstantiated health benefits, the FDA and Federal Trade Commission (FTC) have issued warning letters to sellers for marketing unapproved CBD and Δ -8 THC products and/or making claims lacking scientific substantiation, including for treating coronavirus disease 2019, Alzheimer's disease, cancer and multiple sclerosis [31, 39–41]. The FTC can regulate advertising claims about cannabis products to ensure health benefit claims are supported by scientific evidence, while FDA can take enforcement action against products deemed unapproved when they make claims about treatment of medical conditions or for other therapeutic uses [40, 42]. Hence, findings from this study suggest that proactive online cannabis marketplace monitoring could help enhance enforcement of existing laws and regulations and better ensure correct representation of CDP risks and benefits. It could also help regulators identify higher risk CDPs with more concerning claims, while also identifying the need to enforce mandates on requiring health warnings for online CDP listings. Further, the potential reclassification of marijuana to a Schedule III drug may also impact future CDP commercial marketing practices, necessitating the development of best practices on marketing restrictions, a recommendation also highlighted

in the 2024 NASEM report on cannabis policy that should be supported with additional research [30].

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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DATA AVAILABILITY STATEMENT

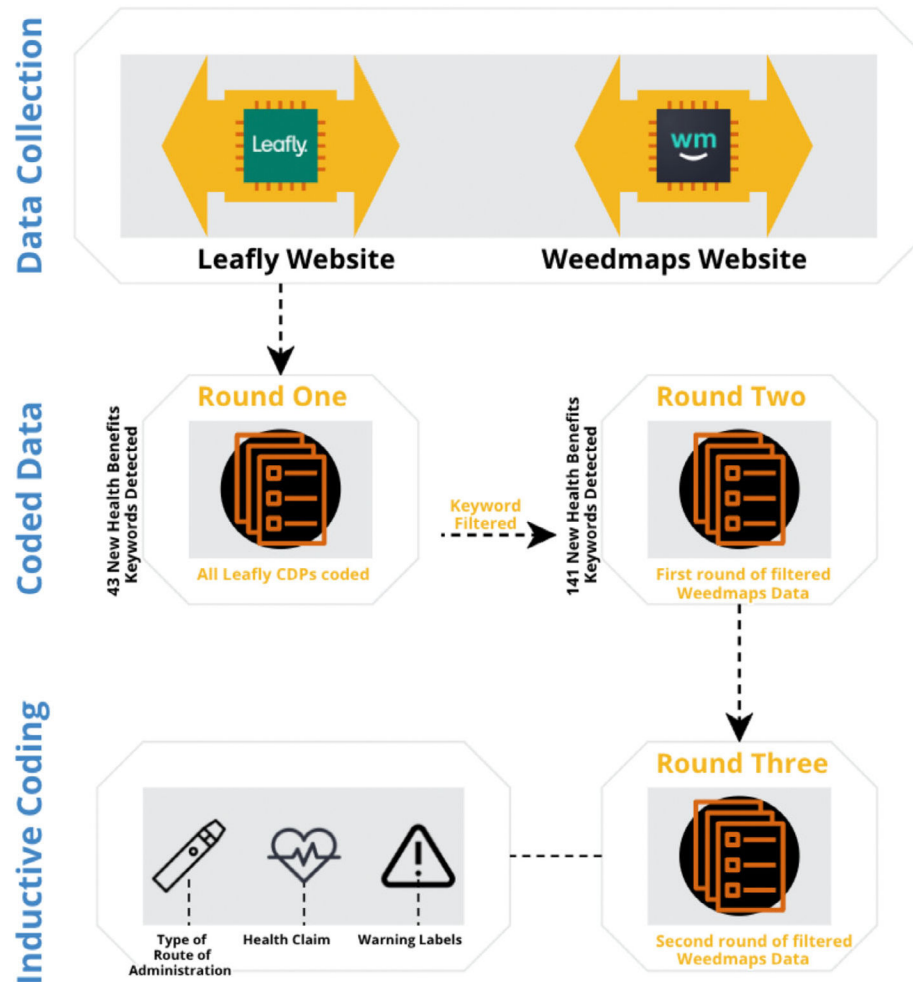
De-identified datasets are available on reasonable request to corresponding author.

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**FIGURE 1.**

Summary figure of methodology process. Manual annotation was first applied to all Leafly data collected to generate an initial signal dataset [i.e. signal here is defined as cannabis-derived product (CDP) listing including a health benefit-related description, ‘Round One’ of Figure 1] because of the smaller volume of data ($n = 50\,951$ unique product listing) generated from this platform compared to Weedmaps ($n = 573\,854$ unique product listings). Next, we cataloged all relevant health benefit description keywords detected from Leafly and categorized them into general health benefit descriptions (e.g. general pain, headache, etc.), undifferentiated health symptoms (e.g. inflammation, anxiety, etc.) and specific disease benefits (e.g. cancer, colitis, etc.). Using these keywords, an initial codebook was created for data mining and filtering of the larger corpus of Weedmaps data. This initial set of keywords was used to filter the full corpus of Weedmaps’ ‘product description’ category to detect similar health benefit descriptions and to identify additional health benefit descriptions that co-occurred in newly detected product listings (‘Round Two’). This process was repeated a third time, similar to a snowball sampling strategy, but applied to any new health benefit description keywords detected, until we achieved thematic saturation where no additional new health benefit description themes were readily observed (‘Round Three’).



FIGURE 2.

Leafly inductive codebook classification and frequency of health benefit claims. Inner circle—broad categories of health, medical or disease conditions. Outer circle—specific health, medical and disease categories within general parent class as informed by standardized medical terminology in MedDRA (v28.0). Note: if a product listing had multiple individual claims that mapped to the same parent or sub-parent class, the parent or sub-parent class was only counted once for the listing.

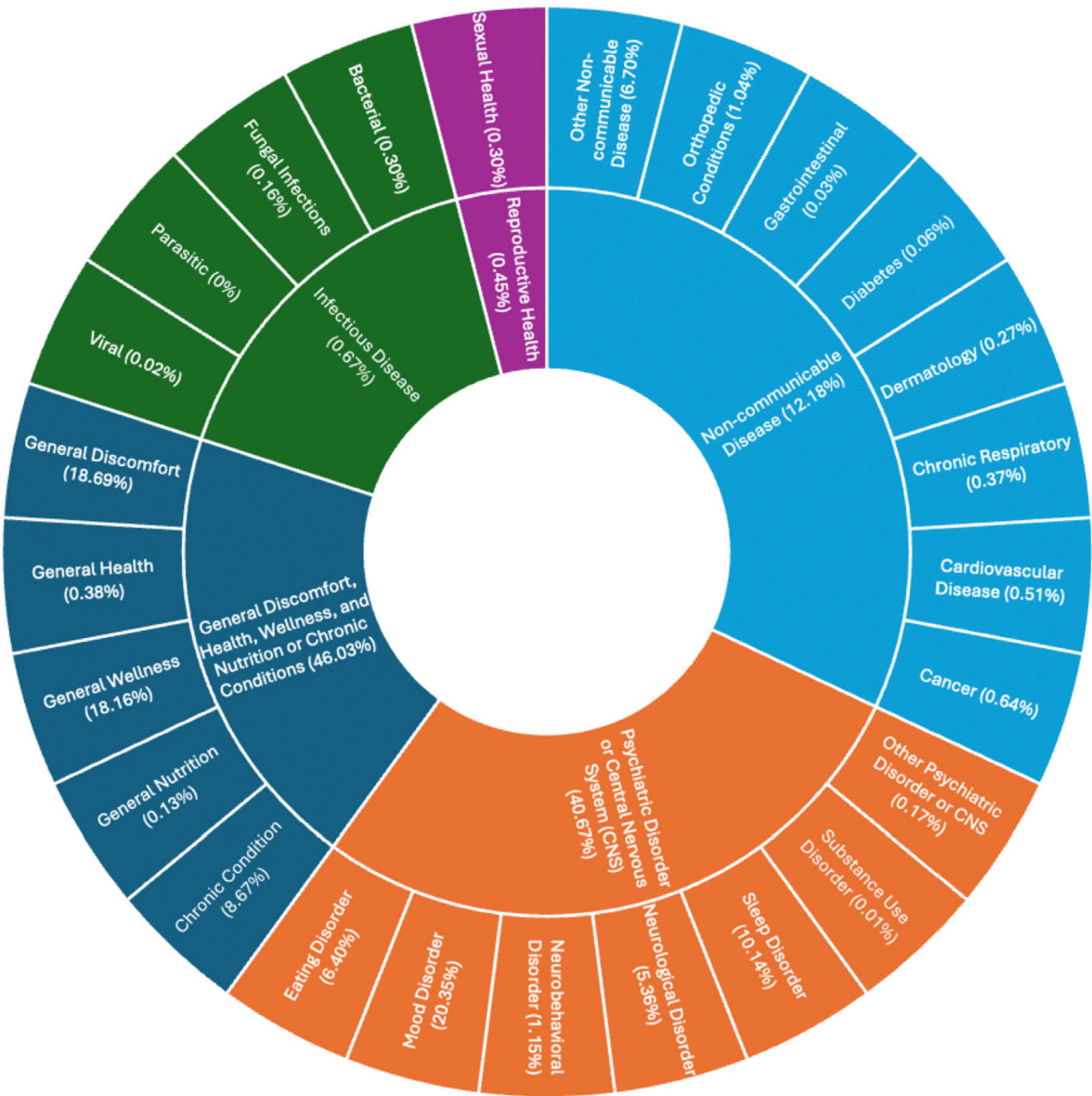


FIGURE 3. Weedmaps inductive codebook classification and frequency of health benefit claims. Inner circle—broad categories of health, medical or disease conditions. Outer circle—specific health, medical and disease categories within general parent class as informed by standardized medical terminology in MedDRA (v28.0). Note: if a product listing had multiple individual claims that mapped to the same parent or sub-parent class, the parent or sub-parent class was only counted once for the listing.

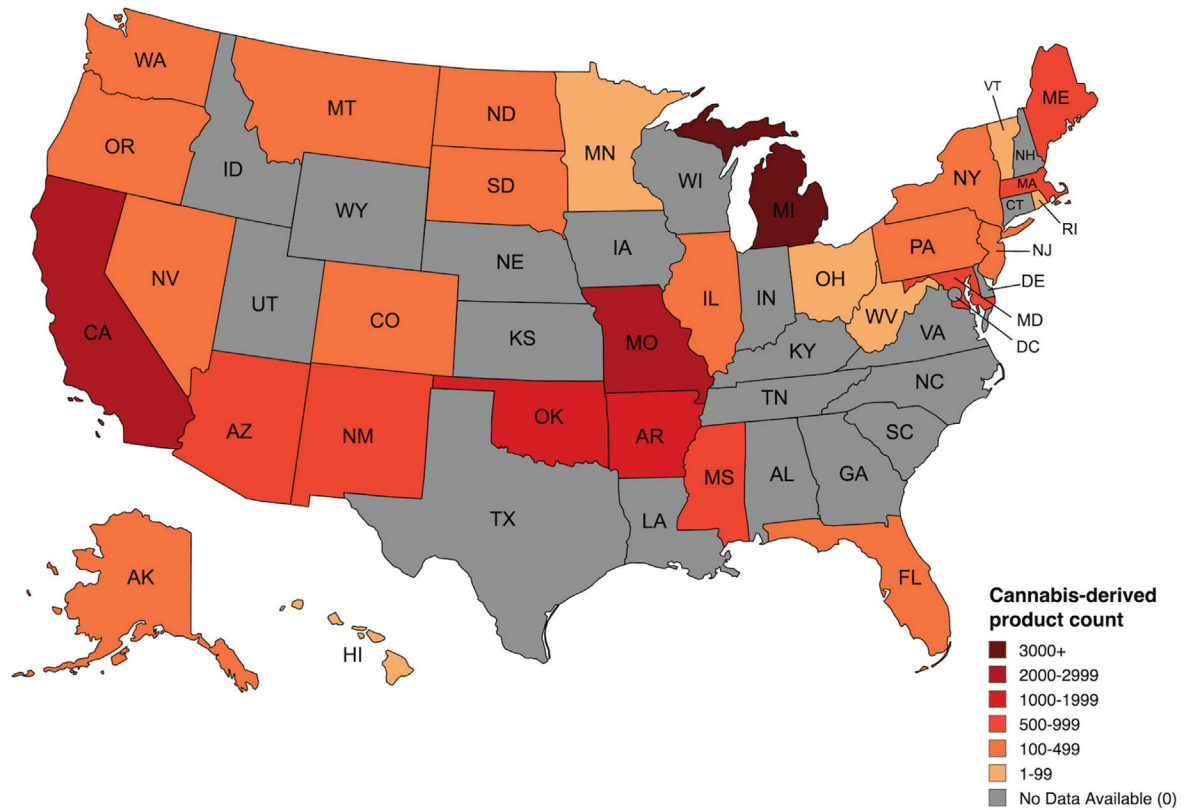


FIGURE 4.

State map of volume of cannabis-derived product (CDP) health benefit claims through listing on Weedmaps. Of the 25 671 CDPs in Weedmaps containing a health benefit claim, a subset ($n = 19\,205$, 74.8%) were successfully linked to retailers/dispensaries across 30 different United States.

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TABLE 1

Examples of CDP with health benefit claims on Leafly and Weedmaps.

Health benefit claim	Product type	RoA	Platform	Image
Seizures, chronic pain, insomnia, heavy menstrual cramps, depression and anxiety	Tablet (edible)	Digestive	Leafly	
Anxiety, depression, cancer, glaucoma, pain and appetite loss	Bud (flower)	Multi-system	Leafly	
Diet changes, stage 4 cancer into remission	Cartridge	Respiratory	Weedmaps	
Cancer, HIV/AIDS, diabetes, insomnia and more	Rick Simpson Oil	Multi-system	Weedmaps	

Abbreviations: CDP, cannabis-derived products; RoA, route-of-administration.