



COMMONWEALTH OF MASSACHUSETTS

Review and Assessment of the Massachusetts Adult- and Medical-use Cannabis Industries

February 2025

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Executive Summary

Massachusetts enacted policy first to decriminalize cannabis in 2008, followed by legalization of medical-use cannabis in 2012, and adult-use cannabis in 2016. The Legislature enacted Chapter 55 of the Acts of 2017 following adult-use cannabis legalization, which established Massachusetts General Law 94G to govern the adult-use cannabis industry. The Cannabis Control Commission (“Commission”) was established to regulate the adult-use cannabis industry, as well as assume regulation of medical-use cannabis in Massachusetts from the Department of Public Health (“DPH”). Inaugural Commissioners were appointed on September 1, 2017, followed by the hiring of most leadership in 2018. The Commission approved and promulgated the state’s first adult-use cannabis regulations in March 2018, and the first Provisional License in June 2018. Adult-use Marijuana Retailers; the first on the East Coast, began operating in November 2018, and medical-use began operating under DPH in June 2015. As of April 2024, the Massachusetts medical-use cannabis industry has been operating for nearly nine years and the adult-use cannabis industry has been operating for nearly six years.

This Commission report serves to assess both the medical-use and adult-use cannabis industries in Massachusetts using available data from November 2018 through April 2024, except where otherwise noted. As of the date of publication, 700 licensees have been approved to commence operations across the Commonwealth, including 201 with RMD/MTC designation. Adult-use cannabis market sales have totaled \$7,086,854,133.61, and medical-use market sales have totaled \$1,379,535,470.98. Please note: the Commission only maintains medical-use cannabis sales data after December 2018, following the transition of the Medical Use of Marijuana Program from DPH and their required use of the agency’s seed-to-sale system of record, Metrc. The demographics of the industry remain predominantly white and male but show increasing racial/ethnic and gender diversity among employees over time. Additionally, the number of registered medical patients nears 100,000 with patterns emerging in patients’ reported diagnoses by age group.

This report utilizes data from multiple sources to construct a broad overview of the progress and current state of the adult-use and medical-use markets. The seed-to-sale tracking system provides descriptive data of cannabis licensees, cultivation, products, and sales. Internal records of medical patients and industry employees from the Massachusetts Cannabis Industry Portal (MassCIP) provide registration and demographic breakdowns of industry owners and employees, and of medical patients. To contextualize results, we include literature reviews on the history of cannabis, the cannabis industry, and public health and safety for the industry, consumers, and general public.

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I. History of Cannabis Laws and Regulations

Federal Regulations

Worldwide, cannabis (“marijuana”) has been used for religious, recreational, and therapeutic purposes for thousands of years, including the United States (U.S.) where its cultivation and use were legal under federal and state laws throughout most of American history. The production of hemp was even encouraged by the government to produce rope, sails, and clothing, its use dating back to the Colonial Era. However, after the Mexican Revolution of 1910 and the Great Depression, the recreational use of cannabis became a public and governmental concern. Federal cannabis prohibition policies started in 1937 with the passing of the Marihuana Tax Act, which restricted the possession and sale of cannabis (Bridgeman & Abazia, 2017). Next, the 1952 Boggs Act, which amended the Narcotic Drugs Import and Export Act, set mandatory sentences for drug convictions, including cannabis. This change carried a minimum sentence of two to 10 years and fine up to \$20,000 and ultimately set up cannabis as an enforcement issue. Rigid policing and President Richard Nixon’s campaign in 1968 led to cannabis’ prohibition being further codified into law in 1970 with the passage of the Controlled Substances Act (Gabay, 2013). As part of this law, cannabis was federally prohibited and classified as a Schedule I substance, meaning that under federal law, cannabis was designated as having 1) high potential for abuse, 2) no accepted medical uses, and 3) no accepted safety data for use under medical supervision. Other Schedule I substances include ecstasy, gamma hydroxybutyric acid (GHB) [[See Appendix Table XI.1. Explanation of General Acronyms](#)], and heroin (Bridgeman & Abazia, 2017). Combined, these changes created the phenomenon of the “War on Drugs,” or the disproportionate enactment and enforcement of cannabis policies, which harmed persons and communities of color.

Cannabis prohibition in the U.S. began to change again in the latter part of the 20th century with state-by-state cannabis decriminalization, which did not legalize cannabis, but instead, replaced criminal sanctions for possession and small-scale casual distribution of cannabis with civil fines. Medical cannabis policies marked the historic change to legalize cannabis for medicinal use. In 1996, California voters passed the Compassionate Use Act (Proposition 215), which permitted cannabis possession and use for those with specific medical [conditions](#). California became the first medical cannabis program in the U.S., and as of July 2024, 39 other states, including Massachusetts, have joined California in legalizing cannabis for medicinal use.

Recent federal regulation in the post-prohibition era has largely taken a state-led approach in which cannabis is still federally prohibited, but states may set their own policies. With the exception of the [Cole](#) and [Sessions memorandums](#) that provided enforcement guidance regarding states with legal cannabis, the federal government has largely kept out of cannabis legalization and regulation. However, this trend may be starting to change, according to the 2022 White House Statement from President Biden on Marijuana Reform. Noting the disproportionate impact of cannabis prohibition on Black, Indigenous, and People of Color (BIPOC), the Biden Administration outlined three steps to end the current failed federal approach. The Administration took the unprecedented step of pardoning all federal offenses of simple cannabis possession and recommended that state governors do the same. Additionally, in a historic change from precedent, President Biden requested the Department of Health and Human Services (HHS) to review marijuana's Schedule I status.

In April 2024, the Drug Enforcement Administration (DEA) signaled its agreement with HHS's recommendation to reclassify marijuana as a Schedule III drug. The DEA is leading a formal rulemaking process to effectuate the reclassification, and the Commission provided [public comment](#) in July, along with stakeholders throughout the nation. While it is too early to conclude what rescheduling will mean for licensed state marijuana programs, there is a likelihood of increased, but still limited, access to research by private and non-profit organizations.

Massachusetts Regulations

In the 21st century, Massachusetts enacted policy first to decriminalize cannabis, followed by legalization for medical use and adult use. In 2008, with the passing of the Massachusetts Sensible Marijuana Policy Initiative, 2008 Massachusetts Question 2, the possession of small amounts of cannabis (i.e., less than one ounce or 28 grams) was converted from a misdemeanor to a [\\$100 fine](#). Four years later, in 2012, voters approved the Massachusetts Medical Marijuana Initiative, [2012 Massachusetts Question 3](#), that established Massachusetts as the 18th state to legalize medical cannabis. Voters legalized adult-use cannabis in 2016 via the Massachusetts Marijuana Legalization Initiative, [Massachusetts Question 4](#), which established Massachusetts as the 6th state to legalize cannabis possession and use for residents ages 21 and older and paved the way for the adult-use cannabis market we know today. Upon passage of Question 4, the Legislature made further amendments and adopted Chapter 55 of the Acts of 2017, which resulted in the establishment of General Law 94G governing adult-use cannabis. The Commission, first appointed September 1, 2017, assumed regulation

of medical cannabis in Massachusetts from the Department of Public Health (DPH), with the initial slate of Commissioners and leadership appointed in [December 2018](#). Massachusetts' first adult-use cannabis regulations were approved by the Commission in March 2018, and the first Provisional License was approved in June 2018. Adult-use cannabis businesses opened for operation beginning in November 2018.

More recently, Chapter 180 of the Acts of 2022, *An Act Relative to Equity in the Cannabis Industry*, was signed into law on August 11, 2022, and went into effect on November 9, 2022. As a result, the Commission was required to amend its existing medical and adult-use cannabis regulations to implement this law. This law significantly impacts the licensed cannabis industry, particularly with respect to the agency's new oversight of Host Community Agreements (HCAs), municipal equity requirements, and agent suitability reform. The Commission voted on September 22, 2023, to approve final changes to the adult and medical use of marijuana regulations, and the regulations were promulgated on October 27, 2023, ahead of the Legislature's deadline.

Laws and Regulations

- Federal Laws Governing the Cultivation, Production, Transportation, or Sale of Medical and Adult-Use Cannabis
 - a. 21 U.S. Code § 812: [Comprehensive Drug Abuse Prevention and Control Act of 1970](#)
- State Laws Governing the Cultivation, Production, Transportation, or Sale of Medical and Adult-Use Cannabis
 - a. St. 2022, c180: *An Act Relative to Equity in the Cannabis Industry* <https://malegislature.gov/Laws/SessionLaws/Acts/2022/Chapter180>
 - b. St. 2017, c. 55: *An Act to Ensure Safe Access to Marijuana* <https://malegislature.gov/Laws/SessionLaws/Acts/2017/Chapter55>
 - c. St. 2016, c. 334: *The Regulation and Taxation of Marijuana Act* <https://malegislature.gov/Laws/SessionLaws/Acts/2016/Chapter334>
- St. 2012, c. 369: *An Act for The Humanitarian Medical Use of Marijuana* <https://malegislature.gov/Laws/SessionLaws/Acts/2012/Chapter369>
- St. 2008, c. 387: *An Act Establishing A Sensible State Marijuana Policy* <https://malegislature.gov/Laws/SessionLaws/Acts/2008/Chapter387>
 - a. M.G.L. c. 94G: Regulation of the Use and Distribution of Marijuana Not

Medically Prescribed:

<https://malegislature.gov/laws/generallaws/parti/titlexv/chapter94g>

b. M.G.L. c. 94I: Medical Use of Marijuana:

<https://malegislature.gov/Laws/GeneralLaws/PartI/TitleXV/Chapter94i>

- State Laws Governing Controlled Substances
- M.G.L. c. 94C: Controlled Substances Act:
<https://malegislature.gov/Laws/GeneralLaws/PartI/TitleXV/Chapter94C>
- State Laws Governing Hemp
 - a. M.G.L. c. 128, Sections 116-123:
<https://malegislature.gov/Laws/GeneralLaws/PartI/TitleXIX/Chapter128>
- Current Cannabis Regulations
 - a. [935 CMR 500 \(masscannabiscontrol.com\) 935 Code Mass. Regs. §500.000](#)
[Adult Use of Marijuana](#)
 - b. [935 CMR 501 \(masscannabiscontrol.com\) 935 Code Mass. Regs. §501.000](#)
[Medical Use of Marijuana](#)
- Guidance Documents and Testing Protocols
 - a. [Guidance Documents - Cannabis Control Commission Massachusetts](#)

Regulatory documents for Massachusetts can be found on the Commission's website:

[Regulations - Cannabis Control Commission Massachusetts](#)

II. Cannabis Background

Overview

Cannabis (Hemp, family Cannabaceae), commonly referred to as ‘marijuana’, was first classified in 1753 by famed Swedish botanist Carl Linnaeus, often known as the “father of modern taxonomy.” Cannabis includes two species, *cannabis sativa* and *cannabis indica*, first distinctly classified in 1783 by Jean Lamarck (Lamarck & Poiret, 1783), and a subspecies, *cannabis ruderalis*, classified in 1924 by DE Janischevsky. The plant has long been used for its therapeutic and psychoactive properties, as well as a variety of household uses. Cannabis was described in the [United States Pharmacopoeia](#) for the first time in 1850 and was used as a patent medicine in the U.S. during the 19th and early 20th centuries (Bridgeman & Abazia, 2017).

[See the Commission’s article, [History of Cannabis Regulation and Medicinal Therapeutics: It’s Complicated](#) for a history of cannabis use and regulation internationally].

Cannabinoids

Cannabinoids refer to a large array of biologically active compounds found in the cannabis plant and human body that bind to cannabinoid receptors in the endocannabinoid system (ECS)(Shevyryn & Morzherin, 2015). Endogenous cannabinoids or endocannabinoids are cannabinoids naturally produced within the human body, such as anandamide (Martin et al., 1999), while phytocannabinoids are cannabinoids naturally produced within the cannabis plant, such as Tetrahydrocannabinol (Ryan et al., 2021). Researchers have classified approximately 278 of cannabis plant compounds as phytocannabinoids, to distinguish them from non-plant endocannabinoids (Hussain et al., 2021). An additional subclassification of cannabinoids are synthetic cannabinoids, which are manufactured cannabinoids not naturally occurring in the plant or human body.

Tetrahydrocannabinol (THC) is the predominant and most-recognized psychoactive phytocannabinoid (Russo, 2007) and is present within the cannabis plant as *delta-9 tetrahydrocannabinol* (D9-THC) at higher concentrations, and its isomer *delta-8 tetrahydrocannabinol* (D8-THC) at much lower concentrations (Food and Drug Administration, 2022). THC is the main intoxicating component of cannabis, which contributes to cognitive effects, potential medicinal effects, and substance use dependence potential (Doonan et al., 2021; Kesner & Lovinger, 2021; Robson, 2011). [Cannabidiol](#) (CBD)

is another major compound found in cannabis that is non-psychoactive, but has anti-inflammatory and [antioxidant](#) effects (Britch et al., 2021). Tetrahydrocannabinolic acid (THCA) is the non-psychoactive acidic form of THC, and cannabidiolic acid (CBDA) is the acidic form of CBD (Atalay et al., 2019; Britch et al., 2021). Chemotype II, where CBD is the prevalent cannabinoid and THC concentration is lower, and (3) Chemotype III, where there is a low THC concentration (Lewis et al., 2018).

[See Commission report, [High Tetrahydrocannabinol \(THC\) Cannabis and Effects on the Human Body: More Research Needed](#) for more information on cannabis-derived THC, potency, and the human body].

Cannabis vs. Hemp

A distinction must also be made between cannabis and cannabis *hemp*, as both belong to the same species of *C. sativa* but differ in their chemical compounds and effects, as well as practical uses. Hemp is selectively bred to produce miniscule levels of Delta-9 THC, with a standard threshold often set at <0.3% D9-THC to distinguish ‘hemp’ from ‘[cannabis](#)’. Hemp plants are harvested for a wide array of uses, including the use of the stalk for textile fibers and biomass (Andre et al., 2016). Since the federal 2018 Farm Bill (Agriculture Improvement Act of 2018; P.L. 115-334, §12619), which legalized hemp, there has been increased and significant interest in hemp’s psychotropic chemical constituents. Although hemp has low concentrations of D8-THC and D9-THC, hemp has several other chemicals that can alter bodily states, most notably CBD (Huang et al., 2023). For more information about the chemical compounds present in cannabis see (Radwan et al., 2021).

It is critical to note that this report solely uses data from the regulated medical and adult-use cannabis markets and does *not* include hemp-derived cannabinoids, which are regulated by the Massachusetts Department of Agricultural Resources (MDAR), not the Commission, in Massachusetts. The 2018 Farm Bill legalized the regulated production of hemp meant for textiles and inadvertently created a new industry of intoxicating synthetic hemp-derived cannabinoids [vs. natural cannabis-derived cannabinoids] for human consumption. Hemp-derived cannabinoids have caused confusion among consumers who are now able to purchase and consume hemp-derived consumable cannabinoid products outside the regulated cannabis industries across the U.S. Policy for both cannabis-derived and hemp-derived cannabinoid consumable products have preceded what science collectively understands about their effects on the human body. This is a critical phenomenon to monitor

and study as there may be crucial differences for both regulation and research of these differing cannabinoids and their associated effects. Currently, in Massachusetts, the Commission is not empowered to assess hemp-derived cannabinoid consumption and behaviors.

Prevalence

Cannabis is the most-used psychoactive substance under international control. In 2020, 209 million consumers aged 15-64 reported use in the past year, a 23% increase from 2010. Although cannabis cultivation occurs in every region worldwide, cultivation has trended upward for the past decade. Prevalence of use is highest in North America, Australia, New Zealand, and West Africa, with great variability in use worldwide. (United Nations Office on Drugs and Crime, 2022). The 2021 National Survey on Drug Use and Health (NSDUH) estimated that about 18.7% of Americans or about 52.5 million people, used cannabis in the past year (Substance Abuse and Mental Health Services Administration (SAMHSA), 2021). In Massachusetts, approximately 35% of residents reported using cannabis in the past year in 2019 and 2020, per the [International Cannabis Policy Study](#).

Modes of Administration

Current cannabis consumption includes varying modes of administration, including smoking, vaporizing, ingesting orally (e.g., edibles), and applying topically or sublingually under the tongue. Oral application was historically a more common mode of medical consumption with a delayed onset of psychoactive effects one to two hours or more after oral ingestion ([Russo 2007](#)). Smoking flower, the most frequently reported mode of administration, produces a rapid onset of psychoactive effects. “Dabbing” has gained traction as a consumption method in recent years, in which highly potent (52-95% D9-THC) concentrated cannabis products are vaporized at 400-600 degrees using a water pipe or another similar vessel (Stogner & Miller, 2015). There has also been a rise in the “vaping” of cannabis, in which cannabis concentrate is contained in a portable form, such as vaporizer cartridges or “vape pens,” and consumed through vaporization and inhalation using a battery (MacCallum et al., 2024). Particular attention has been paid to the prevalence of cannabis vaping for two primary reasons. Research interest in cannabis vaping surged in the 2020s following the 2019 Electronic Vaping Associated Lung Injury (EVALI) crisis in which thousands of individuals nationwide were hospitalized with pulmonary illness following the consumption of vaping products (Rebuli et al., 2023). Further, cannabis vaping prevalence

warrants particular attention due to its high prevalence among youth (Kritikos et al., 2021; Palamar, 2021). [[See Section VIII. Data: Testing: EVALI Crisis](#)].

There is some variability in the estimated prevalence of these modes of administration. In the U.S., traditional flower products (i.e., whole buds/flower, pre-rolls) remain the most popular administration mode reported, but there is evidence that the prevalence of vaping is increasing, particularly among youth (Kritikos et al., 2021; Palamar, 2021). [Massachusetts has observed similar trends](#) among cannabis consumers reporting Flower/Dried Herb, Edibles, and Vaporizers (40%) as the most frequent methods of cannabis consumption (Colby et al., 2022).

III. Methods

Data Time Frame

All datasets included in this report survey trends in the industry from the inception and implementation of Massachusetts’ adult-use Marijuana Retailers in November 2018. Except where otherwise noted, we report data up to (and including) April 30, 2024, the cutoff date for this publication [See Table III.1. Data Sources and Timeframes for a full breakdown of the timeframe and source of each dataset. Data collected after May 1, 2024 will be included in the next Industry Report].

Table III.1. Data Sources and Timeframes

Dataset	Data Source	Start Date	End Date
Adult-use and Medical Market Data – Marijuana Establishments and Medical Marijuana Treatment Centers	Open Data	11/20/2018	4/30/2024
Adult-use Data – Products	Open Data	11/20/2018	4/30/2024
Medical Market Data - Products	Open Data	11/5/2018	4/30/2024
Marijuana Establishment Adult-use Plant Activity and Volume	Open Data	11/20/2018	4/30/2024
Agent Data	Internal (Data request)	11/20/2018	7/31/2023
Patient Data	Internal (Data request)	11/20/2018	7/31/2023
Testing Data	Internal (Data request)	4/12/2021	12/31/2023

*Note: Data source and timeframe of each dataset included in report.

Data Sources

Open Data Overview

Data for this report came from two sources. Data on licensees, product sales, and plant activity are centralized under the [Open Data Catalog](#) via the publicly facing Tableau server

for regulation and monitoring purposes, are regularly updated, and are all freely available to the public. Data related to agent demographics, patient demographics, and product testing are maintained on the Commission’s internal Tableau server and were obtained via the Commission’s Information Technology Department.

Commission regulations require all Marijuana Establishments (MEs), Medical Marijuana Treatment Centers (MTCs), and Independent Testing Laboratories (ITLs) to track cannabis through Massachusetts’ seed-to-sale tracking system [See: [935 CMR 500.105\(8\)\(e\)](#)]. This tracking captures everything that happens to a cannabis plant, from cultivation through harvest and manufacturing of products, including any transportation, inventory storage, and final sale of products to consumers or other licensees. Additionally, all owners, persons with controlling interests, and persons working in the regulated cannabis industry are required to complete an agent registration. Therefore, Massachusetts’ Open Data Platform is a rich data source for cannabis production, manufacturing, sale, and ownership in the regulated industry [See Open Data Platform for publicly available seed-to-sale system tracking and industry data: <https://masscannabiscontrol.com/open-data/>].

For this report, we assess cannabis product, sales, and testing data, owner and employee demographics (e.g. gender, race/ethnicity, veteran status) data, and patient data. For data that we obtained from the Open Data Catalog, and for testing data, we have made the file versions used in our analysis available via the [Data Catalog - Cannabis Control Commission Massachusetts](#).

Adult-use and Medical Market Data – MEs

All data used to report on current trends in MEs is derived from the dataset “Marijuana Establishment License and Applications - Approved, Pending, Re-Opened” available on the Commission’s Open Data Platform. The version used in the report was updated on May 7, 2024, and downloaded on May 13, 2024. Data is inclusive of adult-use and medical licensees, which include co-located licensees (adult-use and medical) that have submitted or begun the application process for ME licensure in Massachusetts. MEs may hold multiple licenses with certain exceptions and limits on ownership (for example, entities may not have ownership over more than three Marijuana Cultivator, Marijuana Product Manufacturer, or Marijuana Retailer licensees in Massachusetts). Please note that establishments may hold a Final License or Provisional License, but still are not yet fully operational until receiving the agency’s notice to commence operations.

Adult-use and Medical Market Data – Products

All product data used in this report—both for the adult-use and medical cannabis markets—are currently available on the Commission’s Open Data Platform. Adult-use market data can be found in the “ITD Adult-use Retail and Delivery Sales Report Data” dataset, and medical market data can be found in the dataset “Medical Treatment Centers - Facility Statistics.” The versions used in the report were updated on May 7, 2024, and downloaded on May 28, 2024, and June 5, 2024, respectively. These data are used to track trends in product purchasing, including product type and quantity, in both adult-use and medical markets.

The Medical Use of Marijuana Program was [transferred from DPH to the Commission in December 2018](#), thus, data reporting was not fully implemented until 2019. Further, the “Vape Product” category of product was not fully integrated into widespread usage until December 2019, so all instances of vaporizer products were categorized as “Concentrates” previously.

Data on the price per gram and price per ounce of adult-use cannabis can be found in the dataset “Average Monthly Price per Ounce for Adult-Use Cannabis,” which contains the daily average price for each category. This dataset was updated on May 7, 2024, and downloaded on May 28, 2024.

Adult-use and Medical Market Data – Production

All production data in this report is currently available on the Commission’s Open Data Platform. Adult-use market data can be found in the dataset “Marijuana Establishment Adult-Use Plant Activity and Volume.” The version used in the report was updated on May 7, 2024, and downloaded on May 24, 2024. Medical market data is not available. These data track cannabis plants through the stages of cultivation and harvesting, as described under this report’s *Production Data* section, via daily totals of the number of plants in each stage. This dataset does not contain information about cultivators (such as facility names or locations), product manufacturing, or eventual sales.

Agent Data

All agent data used in this report was acquired through the Massachusetts Cannabis Industry Portal (MassCIP) through a data request with the Commission’s Information Technology

Department. This dataset is used to collect and monitor the demographic makeup of agents within the industry, including agents' race/ethnicity, gender, and their status as a veteran or farmer. Further, this dataset also tracks the applicant's status as either an Economic Empowerment Applicant (EEA) or a participant of the Commission's Social Equity Program (SEP). Although this dataset is not publicly available, similar condensed datasets detailing agent gender and race/ethnicity trends can be found in the Open Data Catalog.

Agent data, including all demographic information, was extracted from registration forms filled out and submitted to the Commission prior to employment at Massachusetts cannabis facilities ($N=20,753$) as of July 2023. All analyses of descriptive statistics were conducted in R using the "psych" package (Revelle, 2024).

Patient Data

All patient data used in this report was acquired through the Medical Use of Marijuana Online System (MMJOS) through a data request with the Commission's Information Technology Department; no patient data is available to the public as of April 2024. Patient data was filtered to only include registrations before July 31, 2023, the last full month of available data for this report.

Patient data, including all demographic information, was extracted from patient registrations submitted to MMJOS ($N=99,622$) as of July 31, 2023. All analyses of descriptive statistics were conducted in R using the "psych" package (Revelle, 2024).

Testing Data

Testing data used in this report was obtained by the Research Department through the Commission's Information Technology Department. This dataset contains test results from April 12, 2021, through December 31, 2023, for three test types: "THC (%) Raw Plant Material" (THC), "THCA (%) Raw Plant Material" (THCA), and "Total Yeast and Mold (CFU/g) Raw Plant Material" (TYM).

Software

Most data cleaning and processing was conducted in R (version 4.3.0) using RStudio (version 2024.04.2+764), and the rest in Microsoft Excel. The data processing included constructing

binary variables from previously grouped variables, such as instances where more than one race was reported by agents, or more than one Disadvantaged Business Enterprise (DBE) category was reported by the owners of an ME. Data cleaning was also used to clean string/text variables, process duplicate records, and standardize date formats.

Descriptive statistics were computed using R and Microsoft Excel. Data visualizations were constructed using Microsoft Excel, Tableau Desktop, and R. Our scripts are available via the [Data Catalog - Cannabis Control Commission Massachusetts](#).

Statistics

This report contains descriptive statistics, such as mean (average), range, and standard deviation. Standard deviation is calculated as the sample (not population) standard deviation unless otherwise indicated. We do not conduct any hypothesis testing or other inferential analyses.

We report Ns (the number of observations or individuals) of 9 or fewer as “< 10” where necessary to protect privacy and anonymity.

IV. Data: Adult-use MEs

Licensing

Prospective licensees first submit an application for review. A small number of submitted applications are complete and require no additional information at the initial application; for the remaining applications, the Commission will issue a request for information (RFI). When all information and materials are present, the application is deemed complete, and the Commission commences background checks and confirms local compliance. If all items are in order, the applicant receives Provisional Licensure and may begin the buildout of their facility. The Commission then conducts a final licensure inspection. If the inspection results are satisfactory, the Commission grants the applicant final licensure, which is the second-to-last step before a business may commence operations. At this part of the process, the applicant can acquire, track, and test marijuana, and hire staff. The Commission then conducts a second inspection before issuing a commence operations notice. When the commence operations notice is issued, the applicant may commence all operations allowed under their license type.

Prior to the Commission acquiring the medical program from DPH, there were significant differences to the application and review process for an ME license versus an MTC license, which were previously referred to as Registered Marijuana Dispensaries (RMDs) under DPH. Changes of note:

- The application for an RMD was a three-part application submitted entirely on paper via mail. In total, the application fees for an MTC license amounted to \$31,500.
- RMDs were not required to utilize a state-regulated seed-to-sale tracking system for cannabis inventory under DPH.
- RMD Agents were required to renew annually, including an annual \$500 application fee for each Agent per year.
- ITLs under DPH were not licensed in the same manner as RMDs. Rather, they were certified in an abridged and separate license certification process.

Following the Commission's acquisition of the medical program:

- The application for an MTC became a single electronic application, mirroring the ME application process, and the application fee was reduced to \$3,500;
- MTCs are now required to track all marijuana and marijuana products in the state-

- regulated seed-to-sale tracking system;
- MTC Agents are now renewed once annually and thereafter tri-annually, mirroring the agent registration process under the adult-use program; and
- ITLs are now registered under the adult-use program and must follow the same regulatory process for submission and renewal to which all other license types must adhere.

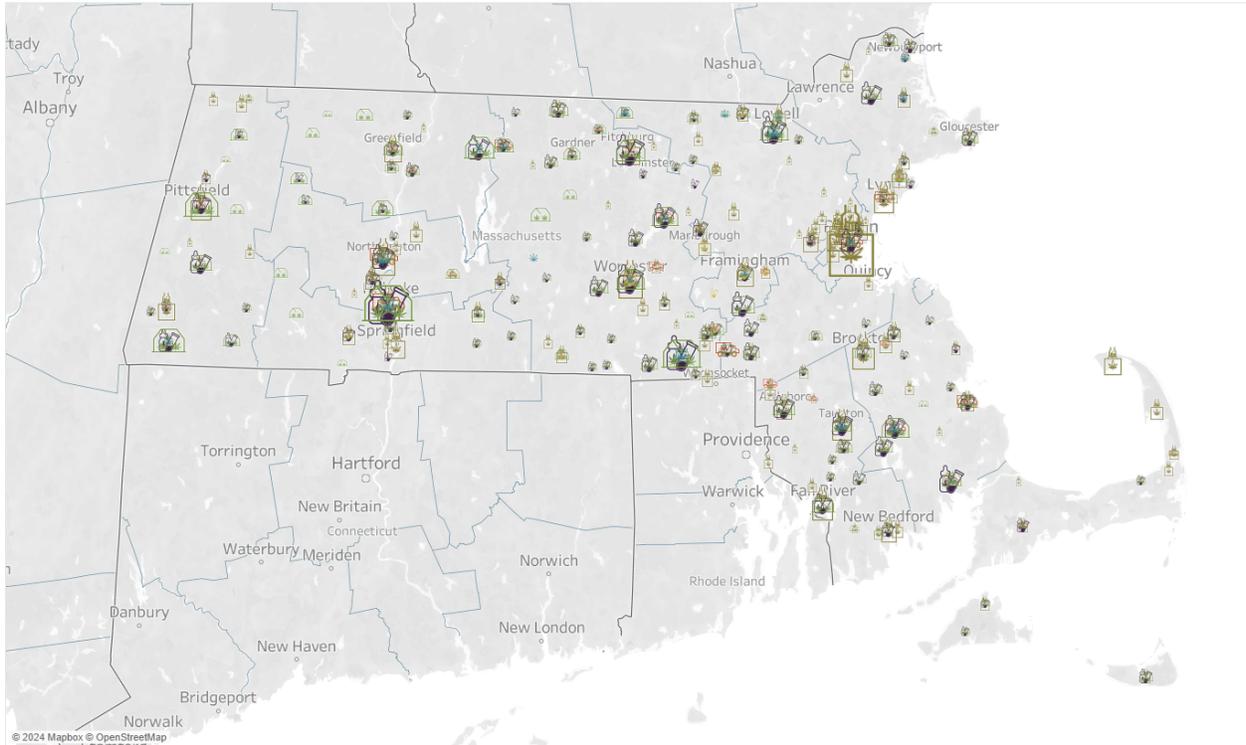
Analysis

This study assesses two distinct sets of licensing statuses to understand the current state of the MEs in Massachusetts, including: 1) applicants and licensees that have not commenced operations, and 2) licensees that have commenced operations. This report assesses both sets of ME categories to draw different sorts of information from the state of the industry in Massachusetts. Investigating all applicants and licensees prior to commencing operations provides a reliable estimate of how many applications have been submitted to the Commission. Establishments with the commence operations designation gives us an estimate of how many licensees have opened their doors and begun conducting operations within the Commonwealth.

Locations

MEs have increased and expanded across the Commonwealth [See Figure IV.1. Adult-Use and Medical-Use Licenses]. As of April 30, 2024, Worcester County contains the greatest number of licensees that have commenced operations (138), followed by Middlesex County (104) [See Table IV.1. Licensees by County]. Nantucket County and Dukes County have the fewest establishments (6 and 4 respectively). While the Commission is responsible for granting licenses, cities and towns differ in their consideration of cannabis businesses, approval processes, and bans for licensee operation within local jurisdictions. In June 2024, the Commission made a historic move to [permit cannabis to be wholesaled to the islands](#) to ensure adequate product supply to island MEs and MTCs.

Figure IV.1. MEs: Distribution of Licenses Across the Commonwealth



License Type (group)	License Type	
Craft Marijuana Cooperative, Microbusiness and Microbusiness Delivery	Craft Marijuana Cooperative	
	Marijuana Microbusiness	
	Microbusiness Delivery	
Independent Testing Laboratory	Independent Testing Laboratory	
Marijuana Cultivator	Marijuana Cultivator	
Marijuana Product Manufacturer	Marijuana Product Manufacturer	
Marijuana Research Facility	Marijuana Research Facility	
Marijuana Retailer	Marijuana Retailer	
Transportation	Marijuana Courier	
	Marijuana Courier Pre-Certification	
	Marijuana Delivery Operator	
	Marijuana Delivery Operator Pre-Certification	
	Marijuana Transporter with Other Existing ME License	
	Third Party Marijuana Transporter	

Table IV.1. Licensees by County

Barnstable	16	2.5%
Berkshire	51	7.9%
Bristol	43	6.6%
Dukes	4	0.6%
Essex	53	8.2%
Franklin	24	3.7%
Hampden	41	6.3%
Hampshire	46	7.1%
Middlesex	104	16.0%
Nantucket	6	0.9%
Norfolk	30	4.6%
Plymouth	55	8.5%
Suffolk	39	6.0%
Worcester	138	21.2%
Total	650	100.0%

*Note: Table lists the count of licensees that have commenced operations within each county. County is determined by the city of the *establishment* address; for Craft Marijuana Cooperatives and the delivery and courier license types, county is determined by the city of the *business* address.

MEs

There are 11 types of ME licenses [See Table IV.2. Adult-Use Market License Types]. As of April 2024, the Commission has approved 650 MEs to commence operations. The most common are Marijuana Retailers (356), Marijuana Cultivators (127), and Marijuana Product Manufacturers (110), which altogether comprise 91.2% of all licenses that have commenced operations [See Table IV.3. Commence Operations (Count), by License Type]. There are two license types (Craft Marijuana Cooperative and Marijuana Research Facility) for which none have commenced operations; both have applications currently under review [See Appendix Table XI.2. Table XI.2. All Applications (Count), Under Review or Operating].

Table IV.2. ME License Types

License Type	Description
Craft Marijuana Cooperative	A Craft Marijuana Cooperative may cultivate, obtain, manufacture, process, package, and brand marijuana and marijuana products to transport marijuana to MEs, but not to consumers.
Independent Testing Laboratory	An ITL means a laboratory that is licensed or registered by the Commission and is: (a) Currently and validly licensed under 935 CMR 500.101, or formerly and validly registered by the Commission; (b) Accredited to ISO/IEC 17025:2017 by a third-party accrediting body that is a signatory to the International Laboratory Accreditation Cooperation’s Mutual Recognition Arrangement or that is otherwise approved by the Commission; (c) Independent financially from any MTC, ME or Licensee; and (d) Qualified to test Marijuana and Marijuana Products, including marijuana infused products, in compliance with M.G.L. c. 94C, § 34; M.G.L c. 94G, § 15; 935 CMR 500.000; 935 CMR 501.000: <i>Medical Use of Marijuana</i> ; and Commission protocol(s).
Marijuana Courier	A Marijuana Courier may deliver marijuana or marijuana products directly to consumers or patients from a Marijuana Retailer or MTC.
Marijuana Cultivator	A Marijuana Cultivator may cultivate, process, and package marijuana, to transfer marijuana to other MEs, but not to consumers.
Marijuana Delivery Operator	A Marijuana Delivery Operator may purchase at wholesale and warehouse finished marijuana or marijuana products acquired from a Marijuana Cultivator, Marijuana Product Manufacturer, Microbusiness or Craft Marijuana Cooperative, and sell and deliver directly to consumers.
Marijuana Microbusiness	A Marijuana Microbusiness can perform the same operations as a Marijuana Cultivator and/or Product Manufacturer. However, cultivation is limited to no more than 5,000 sq. ft. of canopy.
Marijuana Product Manufacturer	A Marijuana Product Manufacturer can obtain, manufacture, process, and package marijuana and marijuana products to transfer marijuana and marijuana products to other MEs, but not to consumers.
Marijuana Research Facility	A Marijuana Research Facility means the Premises at which a Marijuana Research Facility Licensee is approved to conduct research.
Marijuana Retailer	A Marijuana Retailer may purchase, repackage, white label, and

	transport marijuana or marijuana products from MEs, and to sell, repackage or otherwise transfer marijuana and marijuana products to other MEs and to sell to consumers.
Marijuana Transporter with Other Existing ME License	A transporter is an entity that solely transports cannabis or cannabis products.
Third Party Marijuana Transporter	A Third Party Marijuana Transporter may purchase, obtain, and possess marijuana or marijuana products solely for the purpose of transporting, temporary storage, sale and distribution on behalf of other MEs, but not to consumers.

Table IV.3. Commence Operations (Count), by License Type

License Type	License Count	% of Total
Independent Testing Laboratory	16	2.5%
Marijuana Courier	10	1.5%
Marijuana Cultivator	127	19.5%
Marijuana Delivery Operator	11	1.7%
Marijuana Microbusiness	12	1.9%
Marijuana Product Manufacturer	110	16.9%
Marijuana Retailer	356	54.8%
Marijuana Transporter with Other Existing ME License	3	0.5%
Third Party Marijuana Transporter	5	0.8%
Total	650	100.00%

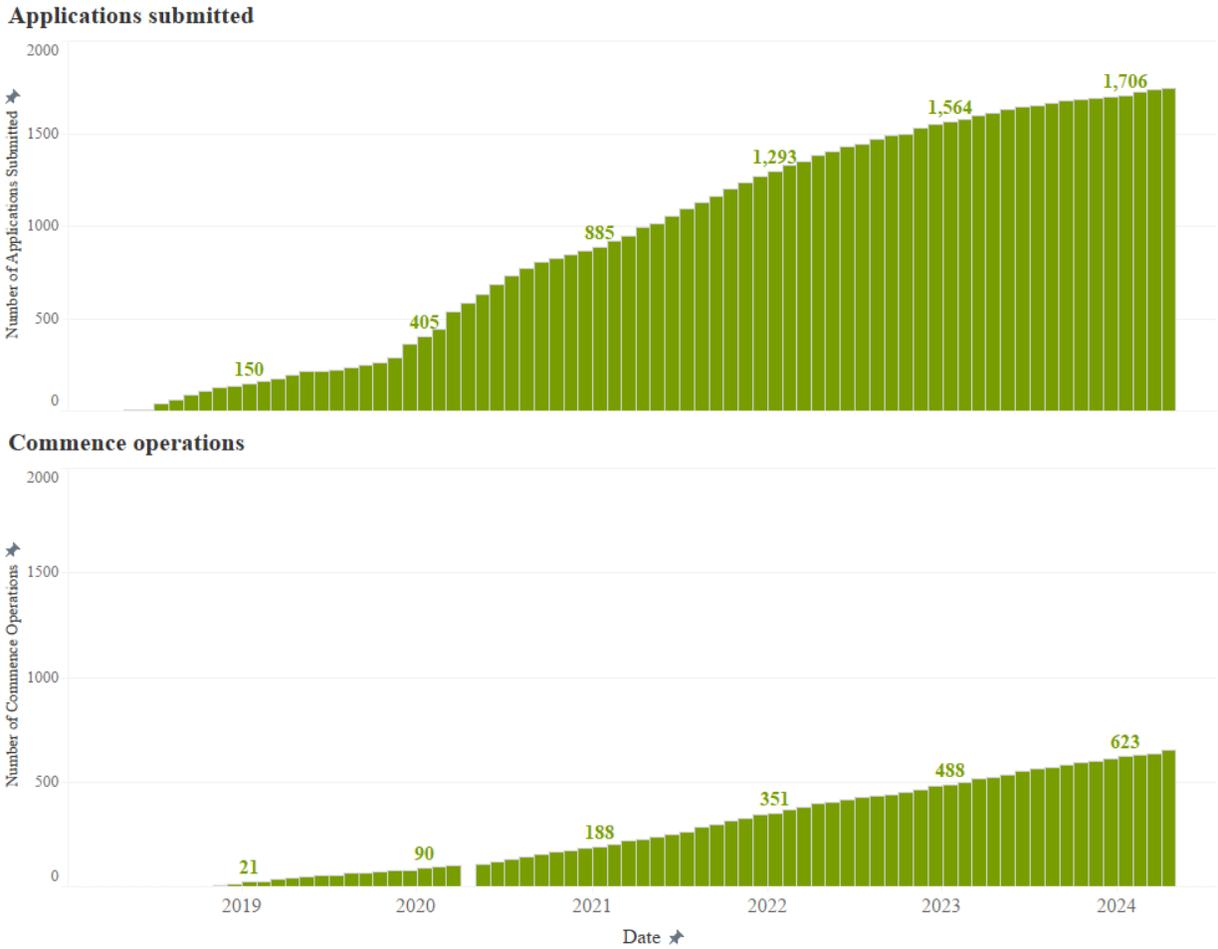
From April 24, 2018, when the Commission received the state’s first ME application, through April 30, 2024, 1,747 applications have been submitted. According to data updated on May 7, 2024, 205 of these applications are in process, 120 are under provisional consideration, 717 have received a Provisional License, 55 have received a final license, and 650 have been approved to commence operations [See Table IV.4. Licenses (Count), by Application Stage].

Table IV.4. Applications (Count), by Stage

Application Stage	Application Count	% of Total
In Process	205	11.7%
Pending	38	2.2%
Reopened	167	9.6%
Provisional Consideration	120	6.9%
Provisional License	717	41.0%
Final License	55	3.2%
Commence Operations	650	37.2%
Total	1,747	100.0%

Application submissions increased from 137 in 2018 (when the Commission began accepting applications) to a peak of 510 in 2020 [See Figure IV.2. Commence Operations, by Year and Table IV.5. Application Submissions (Count), by Year]. There were 49 submissions from January through April 2024. Eleven licenses were approved to commence operations in 2018, with a peak of 160 in 2021, and 41 so far in January through April 2024 [See Table IV.6. Commence Operations (Count), by Year, and see Appendix Table XI.3. Licensees (Count), by License Type and Year of Commencing Operations for the number of licensees under each license type that commenced operations each year]. As the Commission is still a new and growing agency, the size of the licensing team also increased from two staff members in 2018 to 16 at the end of 2023, which may explain the longer wait time in earlier years [See Table IV.5. Application Submissions (Count), by Year].

Figure IV.2. Commence Operations, by Year



*Note: This figure represents the cumulative total of all applications submitted (top) and all licenses approved to commence operations (bottom) from April 1, 2018, through April 30, 2024. This figure does not reconcile closures after a licensee has commenced operations.

Table IV.5. Application Submissions (Count), by Year

Application Submission Year	Application Submission Count	Number of Licensing Staff at Year End	Number of applications reviewed, Per Licensing Staff (Estimated)
2018	137	2	69
2019	227	6	38
2020	504	9	56
2021	401	12	33
2022	278	14	20
2023	151	16	9
2024	49	-	-
Total	1,747	-	-

*Note: Count of applications submitted each year, the number of staff on the licensing team at the end of each year, and an approximation of the number of submitted applications reviewed by each licensing staff member that year (Submission Count divided by number of Licensing Staff at Year End).

Table IV.6. Commence Operations (Count), by Year

Row Labels	Commence Operations Count	% of Total
2018	11	1.7%
2019	68	10.5%
2020	106	16.3%
2021	160	24.6%
2022	137	21.1%
2023	127	19.5%
2024	41	6.3%
Total	650	100.0%

*Note: This table lists the number of licenses that have commenced operations each year since 2018.

Market Saturation

Market saturation was calculated by looking at two separate data sources: 1) retailer totals from the Commission’s adult-use and RMD/MTC priority market data, and 2) population estimate data pulled from the American Community Survey (ACS) compiled by the United States Census Bureau. This study reports on the 2023 ACS data reported on March 14, 2024; the most recently available dataset at the time of reporting. Saturation estimates are measured using the number of retailers per 100,000 population for each of Massachusetts’ counties. Data for Massachusetts’ counties was compiled from the United Census Bureau API and extracted in R using the “tidycensus” package (Walker & Herman, 2024). Market saturation was estimated by dividing the number of retailers by the overall population and multiplying the product by 100,000 to attain the number of retailers per 100,000 population.

Across all municipalities, there was an average of 5.1 Marijuana Retailers per 100,000 residents, with large variability across regions. Saturation of cannabis retailers was highest in the western counties of Berkshire (18.9) and Hampshire (16.6) and was lowest in Norfolk (1.4) and Middlesex (3.7). Density of retailers with RMD/MTC density was highest in Nantucket (6.9) and Hampshire (6.8) counties, and lowest in Hampden and Norfolk (0.7) counties [See Table IV.7. Massachusetts Population and Adult-Use Cannabis Retailer Density, By County].

Table IV.7. Massachusetts Population and Adult-use Marijuana Retailer Density, By County

County	2023		Retailers		RMD/MTC
	Population Estimate (ACS)	Retailers	Per 100k Population (Estimated)	RMD/MTC Priority Retailers	Per 100k Population (Estimated)
Barnstable County	231,735	15	6.5	4	1.7
Berkshire County	126,818	24	18.9	4	3.2
Bristol County	581,841	26	4.5	5	0.9
Dukes County	20,819	2	9.6	1	4.8
Essex County	810,089	32	4.0	13	1.6
Franklin County	70,836	8	11.3	2	2.8
Hampden County	460,291	23	5.0	3	0.7
Hampshire County	162,502	27	16.6	11	6.8
Middlesex County	1,623,952	60	3.7	18	1.1
Nantucket County	14,444	2	13.8	1	6.9
Norfolk County	727,473	10	1.4	5	0.7
Plymouth County	535,308	29	5.4	13	2.4
Suffolk County	768,425	34	4.4	6	0.8
Worcester County	866,866	64	7.4	20	2.3

RMD/MTC Priority

In total, 237 licensees had both RMD and MTC designation, with another 22 having only the later-established MTC designation (259 total). Since April 2018, and current as of May 1, 2024, 203 of the 259 licensees (78.3%) have commenced operations as an MTC. Another 14 final licenses were issued in Massachusetts, and 36 applications were under provisional consideration (*i.e. provisionally approved applications*).

Under Chapter 55 of the Acts of 2017, RMD licensees that existed prior to the advent of the adult-use market could apply and qualify for ME priority licensing review status in April 2018, before submitting an application for a license in the adult-use market. Of the 203 ME licensees to commence operations under this priority review, just over half were Marijuana Retailers (n = 106; 52.2%) and just under a quarter were Marijuana Cultivators (n = 50;

24.6%). Additionally, there were 43 Marijuana Product Manufacturers (21.1%) that had commenced operations with an RMD/MTC priority.

Summary

Since cannabis businesses first came under the purview of the Commission and within the study period, 1,747 applications for licensure have been received in just over six years. There are 650 licensees currently operating, and 259 of these are establishments with RMD/MTC priority. Growth was greatest over the first 24 months that the adult-use market was operational, with 67 businesses commencing operations in 2019, and 107 commencing in 2020. Retailer growth peaked later, with the greatest number commencing operations in 2021 (97) and 2022 (70). With 41 retailers commencing operations between January 1 and April 30 of 2024, it remains unknown how the growth of Marijuana Retailers in 2024 will compare to previous years as the market continues to grow and change across the Commonwealth.

V. Data: Production

Cannabis production includes the processes associated with the cultivation and harvesting of cannabis plants. Production ability, capacity, and efficiency impact the size of the regulated market and product prices. Generally, commercial cannabis production occurs indoors, because it allows for a continuous and uniform cannabinoid yield. Indoor production requires environmental controls, such as lighting, for vegetative growth and flowering developmental stages, as light is one of the most important environmental factors for plant growth and development due to its effects on photosynthetic activity. Additional environmental conditions that are considered for optimal cannabis growth in production are temperature, humidity, air circulation, substrate, fertilizer rate, electrical conductivity, and pH (Eichhorn Bilodeau et al., 2019). In its guidance documents, the Commission specifies that cannabis cultivation uses significant energy due to three primary energy uses: horticultural lighting, dehumidification, and HVAC ([Energy and Environment Compiled Guidance 2021](#)).

During cultivation, plants are typically grown from seeds, cuttings, or through a tissue culture method called micropropagation ([Sampling and Analysis Protocol 2021](#)). There are many different methods used for cultivating cannabis plants, including hydroponics (as a water medium), pots/trays (as a soil medium), and aeroponics (in which plants are suspended on a wall). Hydroponics and soil are considered the more typical methods of cultivation. Notably, hydroponically grown cannabis is more water-intensive than other crops. However, indoor facilities can set up recycling systems that clean and filter used water to be recycled back into irrigation to negate the amount of freshwater input into the system ([Commission Guidance on Water Use](#)).

To mitigate the impact of increased energy usage, the Commission implements energy requirements for cultivation facilities in the adult-use and medical-use of marijuana regulations. For example, cultivation facilities must maintain written operating procedures that demonstrate compliance with the energy efficiency standards in the regulations. Cultivation facilities must also provide information regarding their energy and water consumption usage as part of each renewal application ([Energy and Environment Compiled Guidance 2021](#)) [See Adult Use of Marijuana Regulations 935 CMR 500.120(11) for energy requirements].

Seed-to-Sale Tracking

Massachusetts’s seed-to-sale tracking system, Metrc, is designated by the Commission as the state’s system of record (“seed-to-sale”) ([MA Seed-to-Sale Guidance 2021](#)). This system captures everything that happens to an individual marijuana plant, from cultivation through growth, harvest, and manufacturing, including transportation—if any—to final sale of finished products. Seed-to-sale tracking utilizes a unique plant identification and unique batch identification. It also tracks agents' involvement with the Marijuana Product. When tracking in Metrc, it is important to note that plants must be weighed individually. Plant production is measured through total plant activity and volume of licensed MEs. This includes total: (1) plant count, (2) mature plant count, (3) plant vegetative count, (4) plant flowering count, (5) plant harvested count, and (6) plant destroyed count. [See Table V.1. Plant State Definitions]. Whereas plants been included in the regulations since 2018, the sale of seeds and clones were more recent additions, clones added in November 2021 and seeds added in May 2023 respectively.

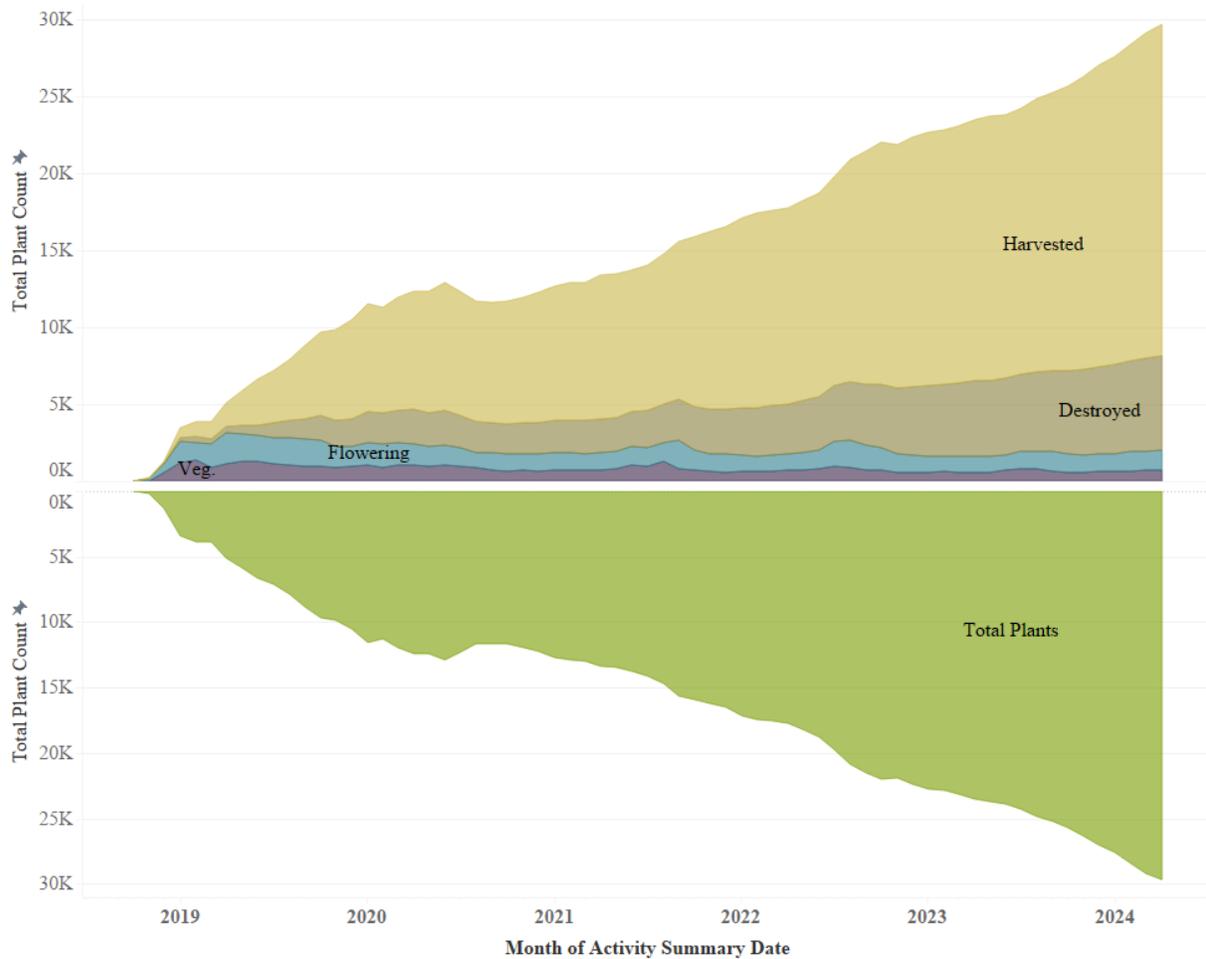
Table V.1. Plant State Definitions

Plant State	Description
Plant Immature	A rooted plant in the Vegetation stage of development that is no taller than 8 inches, no wider than 8 inches, and is in a growing/cultivating container.
Mature Plant	Plants greater than 8” tall or greater than 8” wide.
Plant Vegetative	The state of the cannabis plant which is a form of asexual reproduction in plants, during which plants do not produce resin or flowers and bulk up to a desired production size for flowering.
Plant Flowering	Flowering is the gametophytic or reproductive state of cannabis in which the plant is in a designated flowering space within a cultivation facility with a light cycle intended to produce flowers, trichomes, and cannabinoids characteristic of cannabis.
Plant Harvested	Plant harvested generally refers to plants that are in the drying and curing phase.
Plant Destroyed	Plants destroyed refers to plants that are rendered unusable by the licensee. Plants in this count may not be processed, sold, or given away.
Total Plant Count	The sum/total of all Vegetative, Flowering, Harvested, and Destroyed plants.

Analysis

From January 1-April 30, 2024, an average of 28,797 cannabis plants were legally produced, or were currently in production, per month, in Massachusetts [See Figure V.1. Total Plant Activity and Volume (Monthly Averages), by Year and Table V.2. Total Plant Activity and Volume (Count), by Year]. This total represents all plants (excluding immature plants) that have been through flowering, vegetation, harvesting, and additionally includes plants that were destroyed. Of these, 72% (20,860) had been harvested, and 21% (6,000) had been destroyed. For plants currently in production, 2% (671) were currently in vegetation, and about 4% (1,264) were in the flowering stage.

Figure V.1. Total Plant Activity and Volume (Monthly Averages), by Year



*Note: This figure shows the total plant activity and volume (i.e., total plant count (*bottom*); vegetative, flowering, harvested, destroyed (*top*)).

Table V.2. Total Plant Activity and Volume (Count), by Year

Plant Status					
Year	Vegetative	Flowering	Destroyed	Harvested	Total Plants
2018	253.3	333.1	16.5	67.9	670.8
2019	1,089.0	1,595.9	931.3	3,301.8	6,918.0
2020	892.1	1,239.3	2,091.3	7,780.2	12,002.9
2021	815.3	1,218.8	2,439.7	9,818.0	14,291.7
2022	728.7	1,259.7	3,662.2	13,965.4	19,616.0
2023	643.9	1,088.3	5,085.2	17,620.9	24,438.2
2024	671.4	1,264.7	6,000.1	20,860.5	28,796.7

Summary

The Commission has been tracking data on regulated cannabis market production trends since adult-use operations commenced in 2018. In 2024, just under 29,000 cannabis plants have been or are currently in production in the Massachusetts cannabis industry, 93% (26,861) of which have already been processed, and 7% (1,936) of which are currently in production.

VI. Data: Products and Sales

Cannabis Products in the Regulated Markets

Adult-use Market

There are various types of cannabis products, including dried flower, oils, solid concentrates (such as ‘shatter’), and edibles. The various cannabis products can be consumed through different modes of administration, such as smoking, vaping, dabbing, and ingesting orally. The mode of administration called dabbing involves vaporizing high-potency concentrates using a ‘dab rig’ device at temperatures of approximately 400–600 degrees Fahrenheit. Additional devices used to consume cannabis include bongos, joints, vaporizer pens, and blunts (Wadsworth, Craft, et al., 2022). THC is metabolized differently depending on the mode of administration. Smoking or vaping cannabis can lead consumers to feel acute psychoactive effects more rapidly for a shorter duration of time, compared to orally consuming cannabis, which leads to a delayed onset of acute psychoactive effects that are experienced for a longer duration of time. Transdermal products, such as topicals, have the slowest absorption and lowest intoxicating effects for consumers (Hammond et al., 2022).

Researchers continue to find that smoking dried flower is the most common route of administration in Canada and the U.S. High-potency products such as edibles and other cannabis concentrates are also increasingly prevalent in jurisdictions that have legalized adult-use cannabis (Hammond et al., 2022; Wadsworth, Craft, et al., 2022). A study conducted by Hammond et al. (2022) found that U.S. states with legalized adult-use cannabis had a higher prevalence of use for all processed products, with edible use prevalence substantially higher: 64% of consumers reported past 12-month use in 2020, compared to the 72% of consumers that reported dried flower use (Hammond et al., 2022).

Notably, cannabis consumers, including patients, often use multiple administration routes, which highlights their interest in the variety of available cannabis products. Researchers have also found increasing interest among patients in cannabis products that contain CBD (Boehnke et al., 2019; Sexton et al., 2016) [See Table VI.1. Product Category Descriptions below for all product types available in Massachusetts].

Table VI.1. Product Category Descriptions

Broad Category	Category	Description
Buds	Buds	The actual nuggets that a consumer grinds and smokes. Buds are the part of the cannabis plant that contain the cannabinoids including THC, CBD, CBG, and THCV.
Concentrates	Concentrate ⁺	A concentrate is any type of cannabis product that is refined from flowers into a more purified and potent form. A concentrate can refer to any form of hash, kief, or hash oil (<i>e.g. CO2, BHO, shatter, budder, wax</i>).
	Concentrate (Each)	See above. The difference with this item category is that the data reporter can make this a count-based item. This is generally seen in prepackaged concentrates that are a standard weight that are easier to manage from an inventory perspective.
	Concentrate (Bulk)	An item or production batch or categories for use in Product Manufacturing licenses when creating intermediary product. These would not be allowed to be transferred for sale.
	Kief	Kief is a result of separating trichomes from the cannabis plant. Kief is a powdery substance that holds the most amounts of cannabinoids, making it potent and a very pure form of concentrate. Not typically sold to patients/consumers and is used primarily in Product Manufacturer licenses to produce concentrates.
Cultivation	Fresh Frozen Flower	Description by Metrc not provided; however, Fresh Frozen Flower is referenced in the Massachusetts Seed-to-Sale Guidance under #11 (Massachusetts Seed-to-Sale Guidance).
Cultivation	Immature Plants	A non-flowering Marijuana plant that is no taller than eight inches and no wider than eight inches produced from a cutting, clipping, or seedling, and that is in a growing/cultivating container.
	Seeds	Seeds of the plant genus Cannabis within the plant family Cannabaceae.
Infused Edibles and Beverages	Infused Beverage	Drinks that contain cannabis extracts or concentrates. An infused beverage is considered an edible.

	Infused Beverages (Bulk)	An item or production batch or categories for use in Product Manufacturing licenses when creating intermediary product in liquid form. This was discontinued in 2021 and changed to infused liquid bulk and it cannot be transferred for sale.
	Infused (edible)	Edibles are cannabis-infused products that are consumed orally. Common forms of edibles include baked goods (<i>e.g. brownies and cookies</i>) and candy (<i>e.g. chocolate, gummies, and lollipops</i>).
Infused (non-edible)	Infused (non-edible)	Cannabis-infused products that are not taken through oral consumption and digestion. This includes a range of products such as tinctures and transdermal patches.
Pre- Rolls	Infused Pre-Rolls	Raw flower (ground bud or shake trim) cannabis that has been infused with a concentrate and rolled with cigarette paper or tobacco leaves prior to sale.
	Raw Pre-Rolls	Raw flower (ground bud or shake/trim) cannabis that was prepared by rolling in cigarette paper or tobacco leaves before its sale.
Shake / Trim	Shake/Trim	Shake is the excess cannabis product that is separated from the nuggets of bud during the packaging process. Trim is the excess snipping of leaves from buds of cannabis plants during the harvesting process. Shake/Trim is lower in potency and quality than buds and is typically used in product manufacturing or producing pre-rolls to be sold to patients/consumers.
	Shake/Trim (by strain)	See above. The difference is this item category requires a strain to be associated with it.
Suppository	Suppository	A solid medical preparation of a cannabis-infused product in a roughly conical or cylindrical shape, designed to be inserted into the rectum or vagina to dissolve.
Vape Product	Vape Product*	A concentrated form of cannabis in which the concentrate is contained in a portable form (such as vaporizer cartridges) and is consumed through vaporization and inhalation using a battery. This battery is often distinct from the cartridge but can also come attached to the cartridge as a disposable.
Waste	Waste	Waste products created from the growing and manufacturing of cannabis-derived goods.

*Note: Product category descriptions are defined by Massachusetts seed-to-sale tracking system provider. A new category was created for vaporizer cartridges and disposable pens on December 12, 2019. Any Vape Product

sales prior to this date were categorized as Concentrate (each)*.

Consumer Demand

Economists generally describe how sensitive a consumer is to changes in the price of a good as the “price elasticity of demand.” The price elasticity of demand measures how much the consumption of a good changes in response to a one percent change in its price. Previous literature has found that the demand for cannabis is responsive to changes in both its monetary price and the non-monetary aspects of price, such as legal risk (Pacula & Lundberg, 2014). Researchers also theorize that cannabis demand can be impacted by neighboring states legalizing adult-use cannabis. One study that focused on Washington and Oregon estimated that demand in Washington shifted after adult-use cannabis sales began in Oregon, with a larger reduction in demand closer to the Washington/Oregon border because Oregon consumers did not need to enter Washington for cannabis (Mace et al., 2020). Additionally, the responsiveness of demand varies considerably across the type of consumer.

A significant price decrease would have very different implications for light consumers, who spend a small share of their income on cannabis, compared to regular or heavy consumers, who spend more of their disposable income on cannabis. Furthermore, while the behavior of regular and heavy consumers represents a much smaller proportion of the total consumers, they represent the majority of quantity consumed (Pacula & Lundberg, 2014).

Analysis

This report primarily utilizes an “item-level” unit of analysis, meaning we analyze each retail product separately, rather than a “transaction-level” unit of analysis which may contain multiple items. This analysis is consistent with similar research.

We analyze trends in medical and adult-use products using a few different metrics: 1) overall revenue, 2) overall market share, 3) price per gram, and 4) price per unit. Overall revenue serves to demonstrate the amount of money made on transactions in both the adult-use and medical markets regardless of product definitions, where overall market share demonstrates this same data with product categories stratified as a proportion of total sales. To estimate the average cost of goods in the adult-use and medical markets, we also look at the average cost of goods by price per unit and price per gram. We opted to include both estimates in our analysis since different product types have different default methods of reporting. For

example, where cannabis flower and concentrates are normally reported in terms of the total grams distributed, other products like edibles and drinks are more frequently reported on a “per unit” basis. We excluded the product category “Waste” from our analyses, as there were only five entries for “Waste” in the dataset, and there were inconsistencies between them complicating metric validity.

Sales from November 20, 2018, through April 30, 2024, totaled \$6,063,229,651.92, including a total of \$524,478,611.31 in 2024 [See Table VI.2. Total Sales by Product Type in the Adult-Use Market and Figure VI.1. Gross Sales in the Adult-Use Market by Product Category].

Buds accounted for the largest portion (42.2%), followed by Vape cartridges (18.4%), Pre-rolls (15.0%), Infused edibles and beverages (14.7%), and Concentrates (7.6%). Year-over-year sales increased most from 2018 to 2019 (537%), and least from 2022-2023 (5%), with a slight uptick again from 2023-2024 (7%) [See Table VI.3. Total Sales in the Adult-Use Market by Year].

Table VI.2. Total Sales by Product Type in the Adult-use Market

Product Category	Product Type	All time	All time %	2024	2024%
Buds	Buds	\$2,556,554,518.29	42.2%	\$218,753,579.98	41.7%
Concentrates	Concentrate	\$31,314,631.60	0.5%	\$3,583,274.29	0.7%
	Concentrate (Bulk)	\$694,834.75	0.0%	\$65,884.33	0.0%
	Concentrate (Each)	\$426,499,555.93	7.0%	\$23,829,704.35	4.5%
	Kief	\$5,562,838.62	0.1%	\$219,134.87	0.0%
Cultivation	Immature Plants	\$434,609.18	0.0%	\$67,851.25	0.0%
	Seeds	\$70,916.35	0.0%	\$46,139.73	0.0%
	Fresh Frozen Flower	\$37,327.19	0.0%	\$13,235.61	0.0%
Infused Edibles and Beverages	Infused (edible)	\$846,583,320.00	14.0%	\$61,749,256.64	11.8%
	Infused Beverage	\$43,727,518.13	0.7%	\$3,590,347.02	0.7%
	Infused Beverages (Bulk)	\$452.00	0.0%	-	-
Infused (non-edible)	Infused (non-edible)	\$35,037,258.61	0.6%	\$1,699,316.94	0.3%
Infused Liquid (Bulk)	Infused Liquid (Bulk)	\$1,069.14	0.0%	\$906.31	0.0%
Pre - Rolls	Infused Pre-Rolls	\$65,225,070.32	1.1%	\$11,864,231.49	2.3%
	Raw Pre-Rolls	\$840,707,064.9	13.9%	\$82,472,180.66	15.7%
Shake / Trim	Shake/Trim	\$22,636,941.30	0.4%	\$4,162,643.11	0.8%
	Shake/Trim (by strain)	\$71,340,670.69	1.2%	\$11,097,373.56	2.1%
Suppository	Suppository	\$58,541.83	0.0%	\$4,879.74	0.0%
Vape Product	Vape Product	\$1,116,742,513.06	18.4%	\$101,258,671.43	19.3%
Total		\$6,063,229,651.90	100%	\$524,478,611.31	100%

*Although “Waste” is an additional category, it is excluded in this table due to metric data validity concerns.

Figure VI.1. Gross Sales in the Adult-Use Market by Product Category

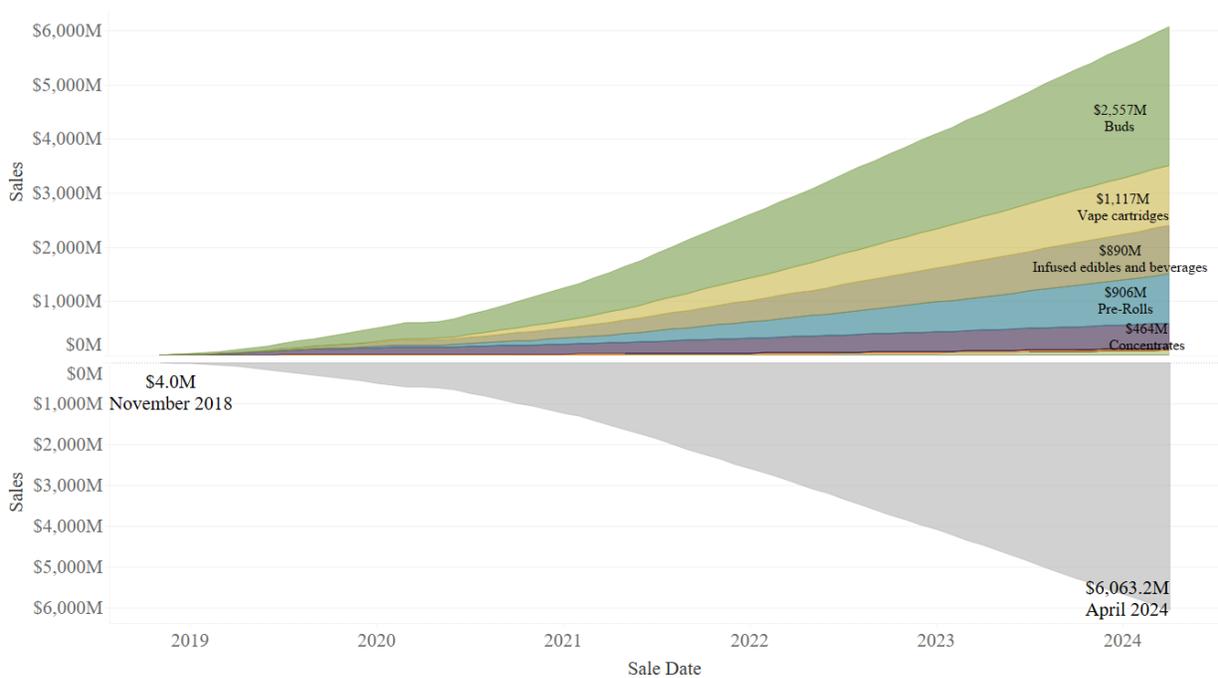


Table VI.3. Total Sales in the Adult-use Market by Year

Year	Total Sales	Year-Over-Year Increase
2018	\$15,213,263.23	-
2019*	\$433,096,256.80	347%
2020	\$702,609,823.36	62%
2021	\$1,332,327,496.67	90%
2022	\$1,488,674,571.04	12%
2023	\$1,566,829,629.51	5%
2024*	\$524,478,611.31	7%
Total	\$6,063,229,651.92	-

*Note: Year-over-year Increases in 2019 and 2024 are calculated differently— The Total Sales shown for 2018 and 2024 encompass only part of each year. The 2018-2019 increase is calculated using sales data from 11/20/2019-12/31/2019 (\$68,035,924.79), to match the dates during which there were sales in 2018. The 2023-2024 increase is calculated using sales data from 1/1/2023-4/30/2023 (\$492,256,653.81), to match the cutoff date for 2024 sales used in this report.

Price per Gram

The price-per gram of adult-use cannabis, calculated as a monthly average, fell from \$14.09 in November 2018 to \$5.36 in April 2024, a 62% decrease. The price per ounce of adult-use cannabis similarly fell from \$401.50 in 2018 to \$153.73 in 2024, also a 62% decrease. Some decreases are expected as the market saturates across the Commonwealth. As the price of cannabis decreases, additional light adult-use cannabis consumers in Massachusetts may enter the market. However, as more East Coast states implement adult-use cannabis legalization, Massachusetts may expect decreases in overall purchases as out-of-state consumers may no longer cross borders to purchase cannabis from Massachusetts as other local markets become operational [See Figure VI.2 Price Per Gram of Adult-use Cannabis and Table VI.4. Average Price for Adult-Use Cannabis Sold in Ounces and Grams, by Year].

Figure VI.2. Price Per Gram of Adult-use Cannabis

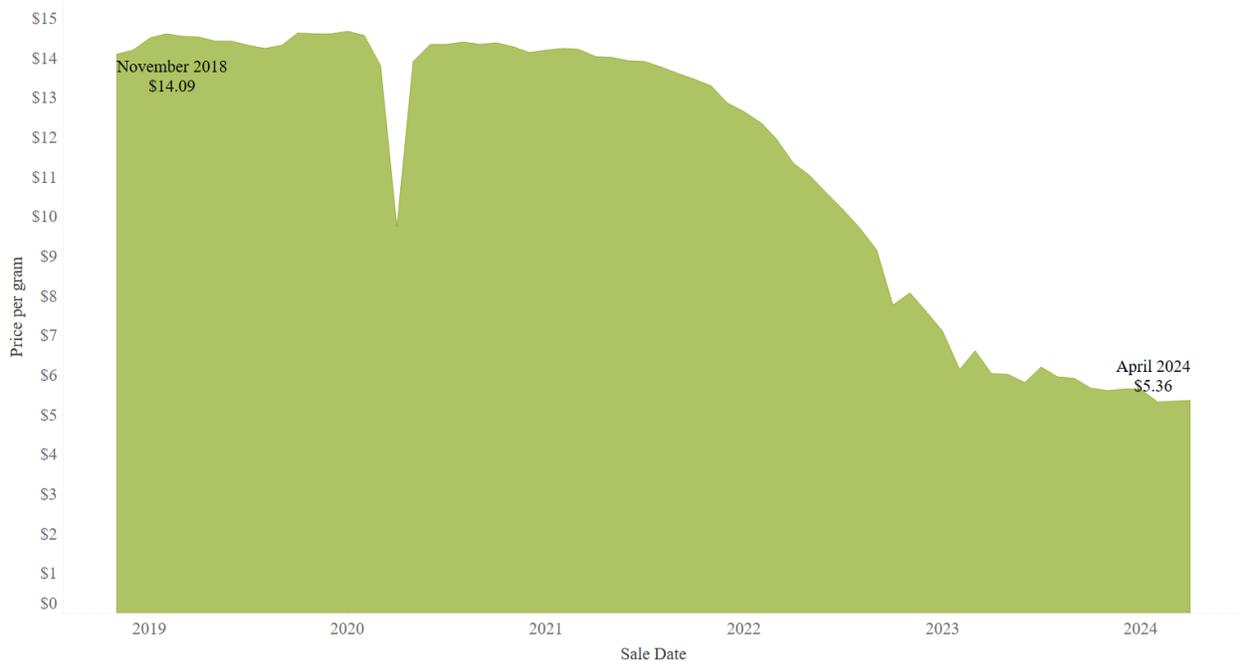


Table VI.4. Average Price for Adult-use Cannabis Sold in Ounces and Grams, by Year

Year	Avg Price per Ounce	Avg Price per Gram
2018	\$401.50	\$14.16
2019	\$410.42	\$14.48
2020	\$400.98	\$14.14
2021	\$391.03	\$13.79
2022	\$288.76	\$10.19
2023	\$172.02	\$6.07
2024	\$153.72	\$5.42

Other weight-based products showed similar trends in price per gram, with most products decreasing in price from their earliest prices to their average price in 2024 [See Table VI.5. Average Price Per Gram of Products Primarily Sold by Weight].

Table VI.5. Average Price Per Gram of Products Primarily Sold by Weight

Product Type	2018	2019	2020	2021	2022	2023	2024
Concentrate	\$100.62	\$70.49	\$68.67	\$67.66	\$52.88	\$34.20	\$29.75
Concentrate (Bulk)				\$54.64	\$56.90	\$33.34	\$29.09
Fresh Frozen Flower						\$3.96	\$5.84
Infused Pre-Rolls		\$22.46	\$25.30	\$26.59	\$26.61	\$22.06	\$16.63
Kief	\$14.83	\$30.57	\$27.27	\$23.04	\$25.56	\$21.31	\$20.12
Raw Pre-Rolls		\$14.72	\$14.21	\$14.97	\$13.50	\$9.90	\$8.84
Shake/Trim		\$14.81	\$18.31	\$11.14	\$5.72	\$3.89	\$3.57
Shake/Trim (by strain)	\$15.04	\$14.45	\$15.04	\$7.60	\$7.01	\$3.95	\$3.55

Price per Unit

The average prices for products typically sold as discrete units, not by weight, also generally fell from 2018 to 2024. The exceptions were Seeds and Suppositories, which are much smaller product categories, making it more difficult to interpret trends and variation in prices

[See Table VI.6. Average Price Per Unit of Products Primarily Sold as Discrete Units, by Year].

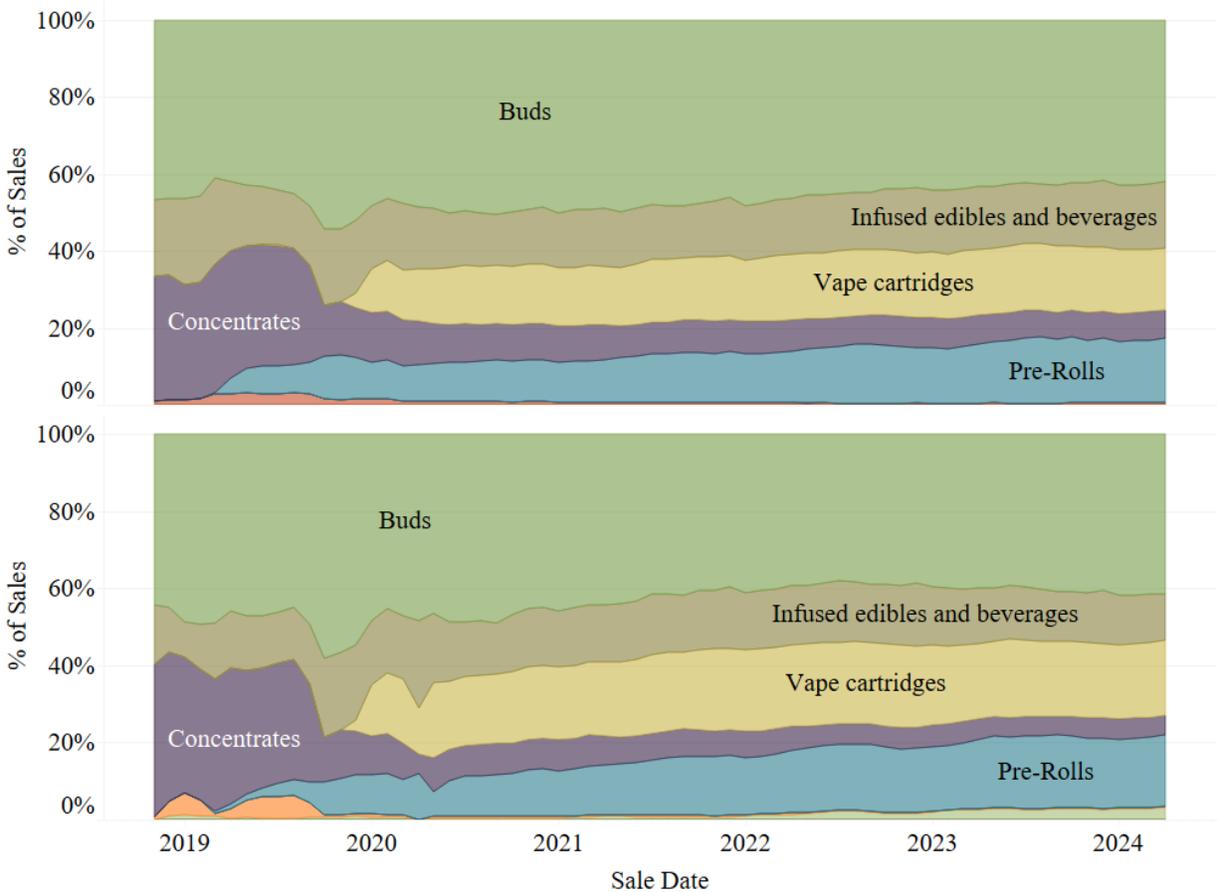
Table VI.6. Average Price Per Unit of Products Primarily Sold as Discrete Units, by Year

Product Type	2018	2019	2020	2021	2022	2023	2024
Concentrate (Each)	\$52.32	\$51.28	\$51.73	\$52.85	\$49.76	\$37.76	\$34.44
Infused (edible)	\$26.12	\$25.80	\$27.50	\$23.84	\$20.89	\$18.78	\$17.21
Infused Beverage	NA	NA	NA	\$8.67	\$12.16	\$8.46	\$7.20
Seeds	NA	NA	NA	\$16.48	\$14.42	\$27.04	\$32.64
Suppository	NA	\$16.00	\$60.00	\$85.85	\$74.87	\$30.88	\$16.36
Vape Product	NA	\$60.40	\$57.69	\$55.66	\$49.51	\$35.17	\$30.70

Medical-use Market

The purchasing trends on the medical-use market were like those from the adult-use market, with the proportion of sales in each product category following similar trends [See Figure VI.3. Sales by Product Type as a Percent of Total by Month].

Figure VI.3. Sales by Product Type as a Percent of Total by Month: Adult-use Market (Above) and Medical-use Market (Below)



- ProductCategory broad
- Buds
 - Infused edibles and beverages
 - Vape cartridges
 - Concentrates
 - Pre-Rolls
 - Cultivation
 - Infused non-edibles
 - Suppositories

From November 5, 2018, to April 30, 2024, the Medical Use of Marijuana Program transacted \$1,268,347,919.30 in total sales. Over this timeframe, Buds accounted for \$591,642,267.80 in total sales, or about 45.6% of all program sales. Infused Edibles and Beverages (\$194.3 million) and Vape products (\$184.8 million) also accounted for large shares of the market, making up 15.3% and 14.6% of total sales in this time, respectively [See Table VI.7. Total Medical Market Sales by Product Category and Type; Figure VI.4. Gross Sales by Product Category in the Medical Market; and Table VI.8. Total Sales in the Medical Market, by Year].

Year-over-year sales increased from 2018-2021, then decreased for the first time from 2021-2022 (-13%), with the trajectory continuing to 2023-2024 (-16%) [See Table VI.8. Total Sales in the Medical Market, by Year].

Table.VI.7. Total Medical Market Sales by Product Category and Type

Product Category and Product		All Time Sales	All Time %	2024 Sales	2024%
Concentrates					
	Concentrate	\$9,311,225.67	0.7%	\$74,480.70	0.4%
	Concentrate (Bulk)	\$176,161.28	0.0%	\$2,657.20	0.0%
	Concentrate (Each)	\$116,971,636.55	9.2%	\$1,097,255.3	6.6%
	Kief	\$1,348,990.05	0.1%	\$9,522.49	0.1%
Cultivation					
	Immature Plants	\$27,058.56	0.0%	\$5,150.94	0.0%
	Seeds	\$3,296.60	0.0%	\$411.54	0.0%
Flower					
	Buds	\$578,153,688.98	45.6%	\$6,770,516.1	40.5%
Infused Edibles and Beverages					
	Infused (edible)	\$186,090,082.71	14.7%	\$2,714,367.9	16.2%
	Infused Beverage	\$8,199,421.66	0.6%	\$164,525.98	1.0%
Infused Non-Edibles					
	Infused (non-edible)	\$10,351,286.20	0.8%	\$88,729.93	0.5%
Pre-Rolls					
	Infused Pre-Rolls	\$11,714,836.46	0.9%	\$415,081.14	2.5%
	Raw Pre-Rolls	\$147,649,880.73	11.6%	\$2,396,878.7	14.3%
Shake and Trim					
	Shake/Trim	\$1,808,563.99	0.1%	\$13,521.83	0.1%
	Shake/Trim (by strain)	\$11,680,014.83	0.9%	\$249,250.31	1.5%
Suppositories					
	Suppository	\$15,779.54	0.0%	\$0.00	0.0%
Vape Cartridges					
	Vape Product	\$184,845,995.49	14.6 %	\$2,728,653.1	16.3%
Total		\$1,268,347,919.30	100%	\$16,731,003.32	100%

Figure VI.4. Gross Sales by Product Category in the Medical Market

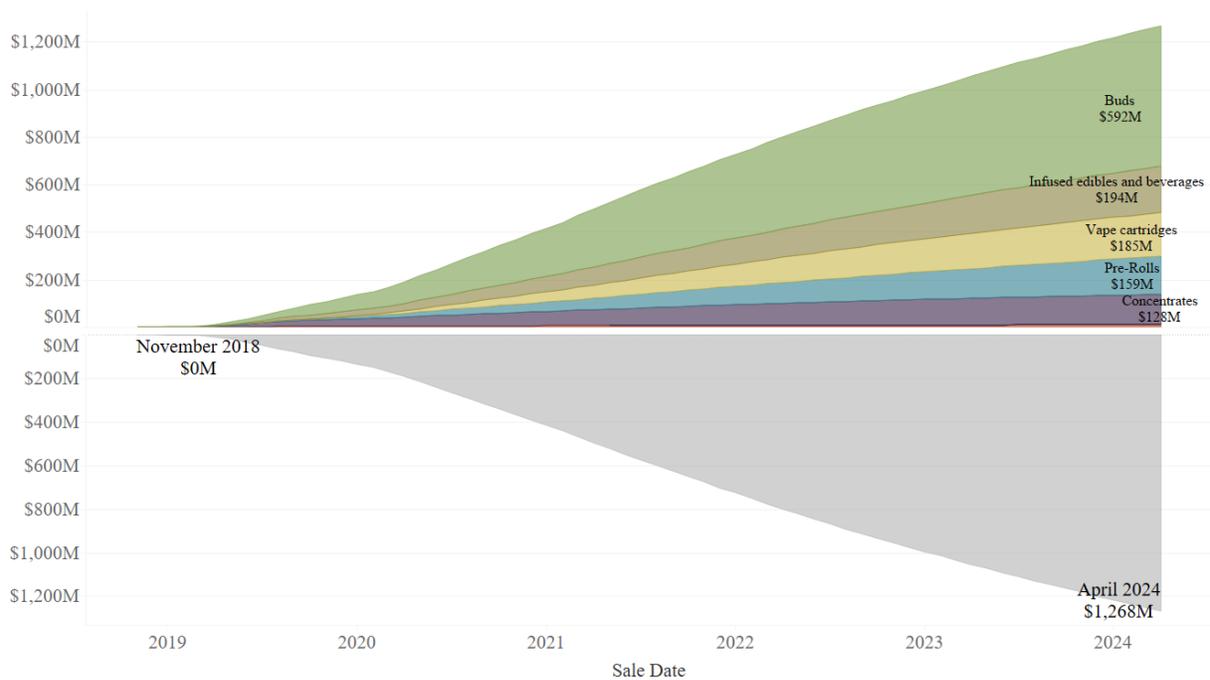


Table VI.8. Total Sales in the Medical Market, by Year

Year	Total Sales	Year-Over-Year Increase
2018	\$1,247,801.86	-
2019 ⁺	\$120,715,829.25	1478%
2020	\$270,416,054.52	124%
2021	\$312,088,097.94	15%
2022	\$271,681,407.41	-13%
2023	\$225,629,940.94	-17%
2024 ⁺	\$66,568,787.38	-16%
Total	\$1,268,347,919.30	-

* Note: Year-over-year increases in 2019⁺ and 2024⁺ are calculated differently, because the Total Sales shown for 2018 and 2024 encompass only part of each year. The 2018-2019 increase is calculated using sales data from 11/20/2019-12/31/2019 (\$19,693,122.62), to match the dates during which sales data is available for 2018. The 2023-2024 increase is calculated using sales data from 1/1/2023-4/30/2023 (\$78,815,311.01), to match the cutoff date for 2024 sales used in this report.

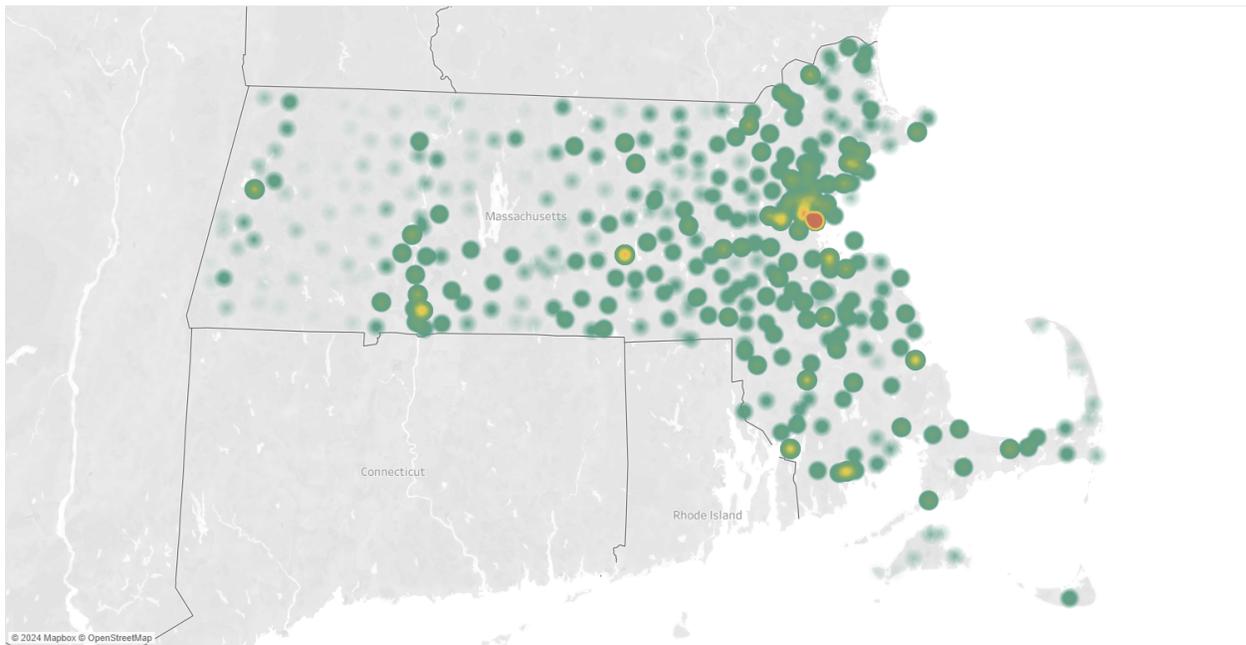
Summary

The adult-use and medical-use cannabis markets in Massachusetts followed similar trends from November 2018 to April 2024. Buds were the highest selling products across both markets, making up the largest share of both the adult-use (42%) and medical-use (46%) markets over the assessed time. Trends were also similar between markets for the next largest products, with Vape cartridges making up 18% of adult-use sales and 15% of medical sales, and Infused edibles making up 14% and 15% of adult-use and medical-use sales, respectively. Year-over-year changes in total sales show that the adult-use market continues to grow, although the pace of growth has declined, while the medical-use market experienced peak sales in 2021 and has declined since.

VII. Data: Patients

As of July 31, 2023, there were 99,622 patients with active registrations in the Medical Use of Marijuana Program, distributed across the entire Commonwealth [See Figure VII.1. Medical Marijuana Program Patient Distribution and Density Across the Commonwealth].

Figure VII.1. Medical Use of Marijuana Program Patient Distribution and Density Across the Commonwealth



Patients

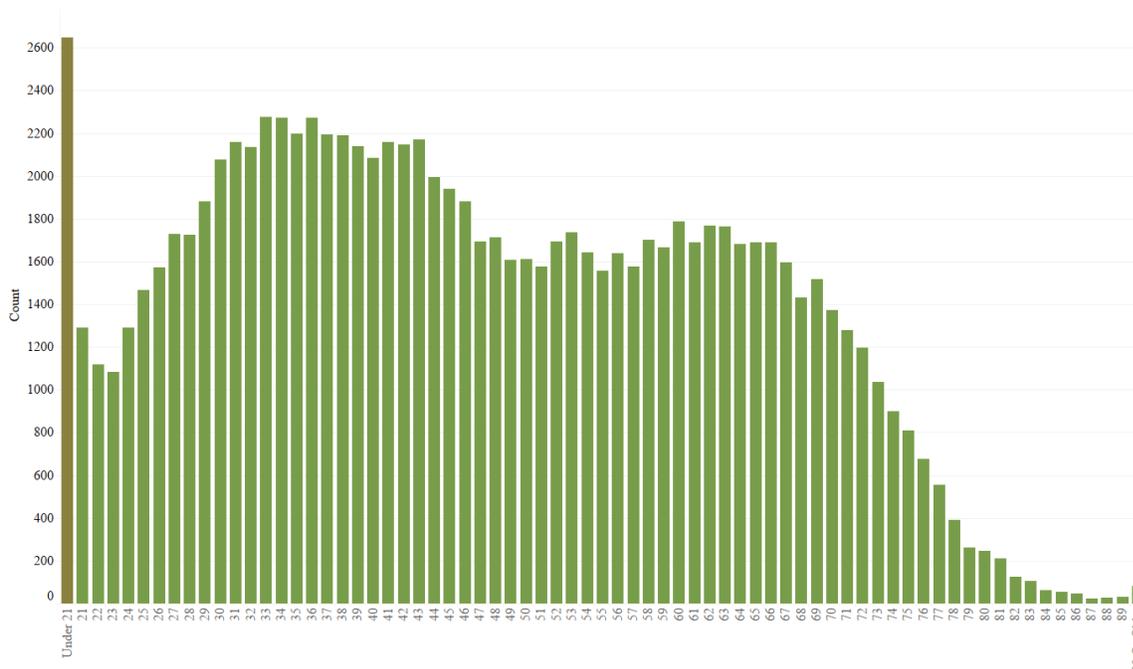
Aggregate data is presented to provide an estimate of the demographic profile of medical marijuana patients in the Commonwealth. This study investigates the Massachusetts patient population stratified by 1) gender, 2) age group, and 3) diagnosis/disease category. Data on diagnosis and disease category provides information on the general category of disease for which the patient is diagnosed (e.g., “Diseases of the digestive system”, “diseases of the nervous system”, etc.) [See Table VII.1. Number and Percentage of Patients, by Age Cohort, Figure VII.2. Patients in the Medical Marijuana Program, Histogram of the Age Distribution, Figure VII.3. Diagnosis Categories as a Percentage of Total Diagnoses, and Table VII.4. Patient Count, By Diagnosis for the total number of patients in each diagnosis category]. The mean age of patients was 46.9 years old ($SD_{age} = 16.0$ years), with approximately 2.7%

($n = 2,648$) of patients aged under 21. A total of 303 patients (0.003%) are considered “minors” (*i.e., aged 18 or younger*) [See Table VII.1. Number and Percentage of Patients, by Age Cohort and Figure VII.2. Patients in the Medical Marijuana Program, Histogram of the Age Distribution].

Table VII.1. Number and Percentage of Patients, by Age Cohort

Age Group	n	% of Total
Less Than 21 Years	2,648	2.7%
21 - 25 Years	6,247	6.3%
26 - 35 Years	20,024	20.1%
36 - 45 Years	21,292	21.4%
46 - 55 Years	16,718	16.8%
56 - 65 Years	16,691	17.0%
66 - 75 Years	12,824	12.9%
76 Years or Older	2,908	2.9%
Total	99,622	100%

Figure VII.2. Patients in the Medical Marijuana Program, Histogram of the Age Distribution



Approximately 51.4% of patients (n = 51,233) identified as men, 48% identified as women (n = 47,812), and 0.6% of patients (n = 577) reported a different gender (e.g. nonbinary, transgender, genderfluid, etc.) [See Table VII.2. Patients (Count), by Self-Identified Gender].

Table VII.2. Patients (Count), by Self-identified Gender

Gender	n	Percent of Total
Female	47,812	48.0%
Male	51,233	51.4%
Other	577	0.6%
Total	99,622	100%

Notable patterns emerged in patients' condition for both age and gender. The most frequently reported qualifying medical conditions were “mental or behavioral disorders”, reported by 52.6% of patients (n = 52,346) [See Figure VII.3. Diagnosis Categories as a Percentage of Total Diagnoses]. There were notable differences when stratified by gender, with 50.1% of men reporting a mental or behavioral disorder (n = 25,647), compared to 55% of women (n = 26,311) and 67% of individuals that reported a gender outside of the gender binary (n = 388) [See Table VII.3. Diagnosis by Patient Gender Cohort]. Prevalence was particularly high among young patients, with about three-quarters (75.4%; n = 1,997) of patients under age 21 reporting a mental or behavioral disorder. Prevalence declines with each successive age cohort and can be most visibly contrasted with adults ages 76 or older, among whom 28.7% (n = 833) reported a mental or behavioral disorder.

Figure VII.3. Diagnosis Categories as a Percentage of Total Diagnoses

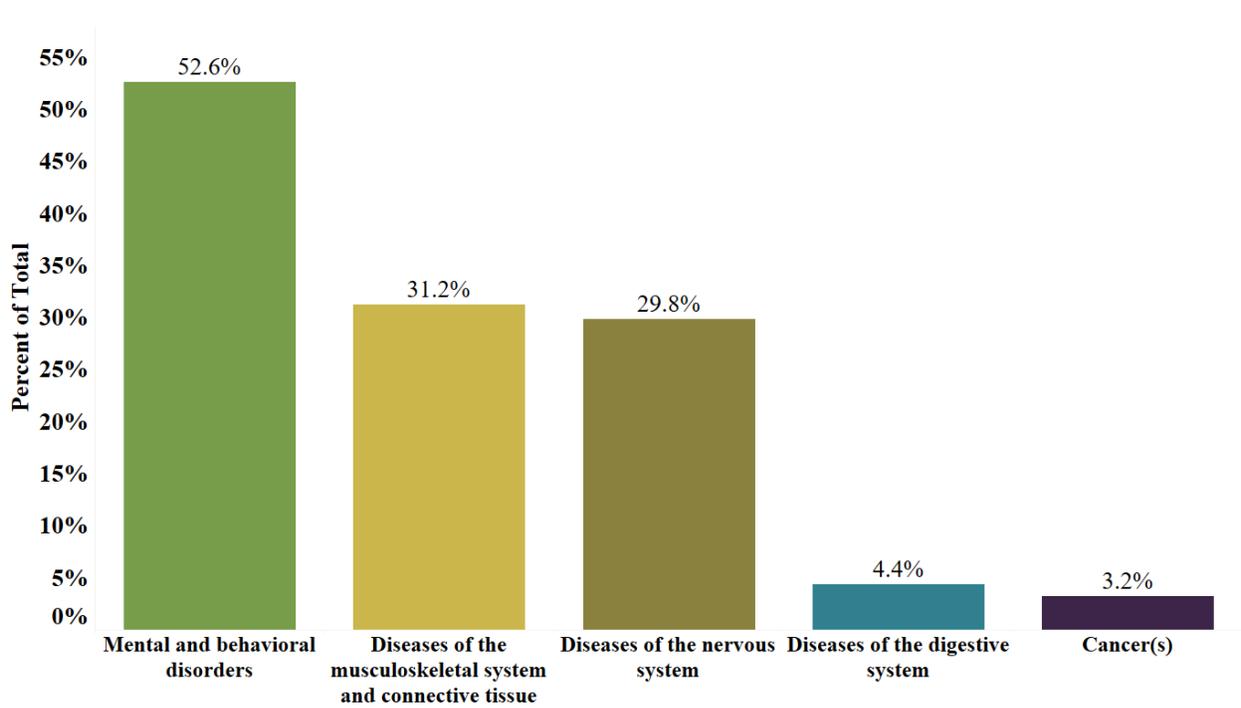


Table VII.3. Diagnosis by Patient Gender Cohort

Specified Diagnoses								
Diagnosis	Female		Male		Not Reported/Other		Total	
	N	Percent of Patients	N	Percent of Patients	N	Percent of Patients	N	Percent of All Patients
AIDS	16	16.0%	85	84.0%	<10		101	<0.1%
ALS	<10		19	<0.1%	<10		26	<0.1%
Cancer	1669	51.0%	1572	48.0%	<10		3,247	3.3%
Crohn's	554	49.1%	570	50.5%	<10		1,128	1.1%
Glaucoma	386	42.0%	523	58.0%	<10		909	0.9%
Hepatitis	123	33.9%	240	66.1%	<10		363	0.4%
Multiple Sclerosis	731	70.0%	311	30.0%	<10		1,044	1.0%
Parkinsons	64	38.3%	103	61.7%	<10		167	0.2%
HIV	47	16.0%	247	84.0%	<10		295	0.3%
Unspecified Diagnoses								

	Female		Male		Not Reported/Other		Total	
Diagnosis	N	Percent of Patients	N	Percent of Patients	N	Percent of Patients	N	Percent of All Patients
Diseases of the blood and blood forming organs and certain disorders involving the immune mechanism	345	69.0%	153	30.6%	<10		500	0.5%
Diseases of the circulatory system	174	45.4%	208	54.3%	<10		383	0.4%
Diseases of the digestive system	2,457	56.2%	1877	42.9%	<10		4,374	4.4%
Diseases of the ear and mastoid process	25	40.3%	37	59.7%	0		62	0.0%
Diseases of the eye and adnexa	53	44.9%	65	55.1%	0		118	0.1%
Diseases of the genitourinary system	624	88.3%	72	10.2%	11	1.6%	707	0.7%
Diseases of the musculoskeletal system and connective tissue	14,882	47.4%	16361	52.2%	124	0.4%	31,367	31.5%
Diseases of the nervous system	14,861	49.9%	14753	49.5%	163	0.5%	29,777	29.9%
Diseases of the respiratory system	101	35.1%	185	64.2%	<10		288	0.3%
Diseases of the skin and subcutaneous tissue	145	55.1%	116	44.1%	<10		263	0.3%
Endocrine nutritional and metabolic diseases	366	50.3%	358	49.2%	<10		728	0.7%
Other Health Factors								
	Female		Male		Not Reported/Other		Total	
Diagnosis	N	Percent of Patients	N	Percent of Patients	N	Percent of Patients	N	Percent of All Patients

External causes of morbidity and mortality	<10							0.0%
Factors influencing health status and contact with health services	20	35.7%	36	64.3%	-		56	<0.1%
Mental and behavioral disorders	26,311	50.3%	25647	49.0%	388	0.7%	52,346	52.5%
Pregnancy childbirth and the puerperium	<10							0.0%
Symptoms signs and abnormal clinical and laboratory findings not elsewhere classified	780	56.0%	605	43.4%	<10		1,394	1.4%

The second most prevalent qualifying medical conditions reported by patients were “diseases of the musculoskeletal system/connective tissue” (31.5%; n = 31,367) and “diseases of the nervous system” (29.9%; n = 29,777). Musculoskeletal system and connective tissue diseases were more prevalent in older adults, with 47.3% of adults (n = 1,375) 76 or older reporting this condition [See Figure VII.4. Distribution of Diagnoses, by Patient Age Cohort]. This diagnosis was less frequent in younger patients, decreasing in each younger age group before reaching its lowest prevalence of 14% (n = 370) in patients under 21. Among specified diagnoses, the most prevalent diagnoses were Cancer (3.3%; n = 3,247), Crohn’s Disease (1.13%; n = 1,128), and Multiple Sclerosis (MS; 1.0%; n = 1,044) [See Table VII.4. Patient Count, By Diagnosis for the total number of patients in each diagnosis category].

Figure VII.4. Distribution of Diagnoses, by Patient Age Cohort

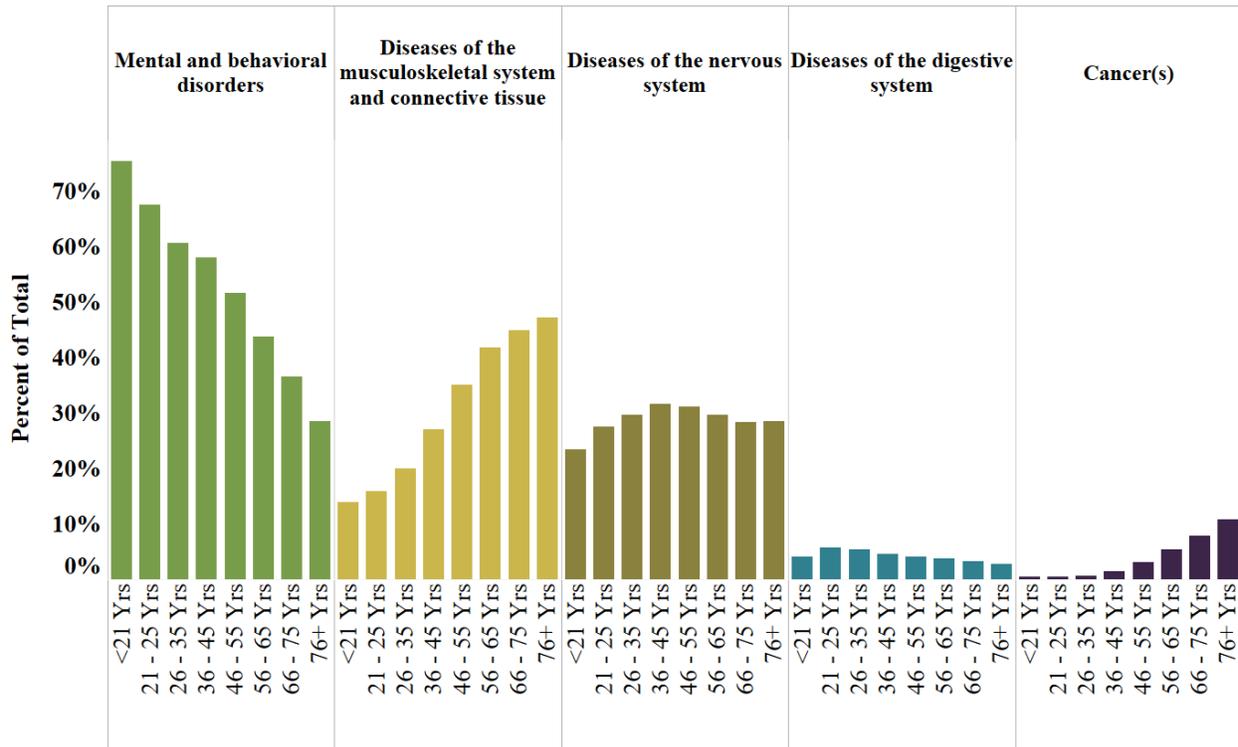


Table VII.4. Patient Count, By Diagnosis

Specified Diagnoses		
Diagnosis	N	Percent of All Patients
AIDS	101	0.1%
HIV	295	0.3%
ALS	26	0.0%
Cancer	3,247	3.3%
Crohn's	1,128	1.1%
Glaucoma	909	0.9%
Hepatitis	363	0.4%
Multiple Sclerosis	1,044	1.0%
Parkinsons	167	0.2%
Unspecified Diagnoses		
Diagnosis	N	Percent of All Patients
Diseases of the circulatory system	383	0.4%

Diseases of the blood and blood forming organs and certain disorders involving the immune mechanism	500	0.5%
Diseases of the digestive system	4,374	4.4%
Diseases of the ear and mastoid process	62	0.0%
Diseases of the eye and adnexa	118	0.1%
Diseases of the genitourinary system	707	0.7%
Diseases of the musculoskeletal system and connective tissue	31,367	31.5%
Diseases of the nervous system	29,777	29.9%
Diseases of the respiratory system	288	0.3%
Diseases of the skin and subcutaneous tissue	263	0.3%
Endocrine nutritional and metabolic diseases	728	0.7%
Other Health Factors		
Diagnosis	N	Percent of All Patients
External causes of morbidity and mortality	7	0.0%
Factors influencing health status and contact with health services	56	0.0%
Mental and behavioral disorders	52,346	52.5%
Pregnancy childbirth and the puerperium	8	0.0%
Symptoms signs and abnormal clinical and laboratory findings not elsewhere classified	1,394	1.4%

Summary

There were nearly 100,000 patients registered with the Commonwealth’s Medical Use of Marijuana Program as of July 2023. The largest age group was patients 36-45 years old; less than 6% of patients were under age 21 or over age 75. Approximately half of patients identified as male, and half identified as female. Mental and behavioral disorders comprised 53% of all diagnoses and were more than twice as prevalent among the youngest patients than among the oldest. By contrast, diseases of the musculoskeletal system and connective tissue (31%) and cancers (3%) were far more common among older than younger patients.

VIII. Data: Testing

Background

Massachusetts Regulations

Commission Testing Regulations are as follows:

Per G. L. c. 94G, § 15, regulations for sampling, testing, and analysis must be based on the most recent [United States Pharmacopeia](#) (USP) guidelines. The goals are to standardize testing methods.

Per 935 CMR 500.002 and 935 CMR 500.160, ITL methods must be accredited to the International Organization for Standardization/the International Electrotechnical Commission (ISO/IEC) 17025:2017. These regulations list the protocols for sampling and analysis of finished marijuana products and environmental media.

[See: 1) [Guidance Documents](#) on the Commission website for testing and analysis protocols for cannabis products and 2) [935 CMR 500.160](#) and [935 CMR 501.160](#) for regulations on testing cannabis and products for MEs and MTCs].

Licensees are expected to cultivate and harvest cannabis in traceable “cultivation batches,” such that all cannabis within a cultivation batch has been produced with the same seed or plant stock, soil or other solid growing media, water, other agricultural/hydroponic inputs, and growing conditions. Cultivation batches are expected to be sequentially numbered and traced throughout post-harvest production steps, and manufacturing/processing batch numbers must be included on the labels of all products to facilitate product recalls. All cultivation methods place the plants in contact with environmental media and other inputs, such as soil or agricultural products, which have the potential to introduce chemical or biological contaminants, making testing a critical regulatory requirement. As it is not possible to test all cannabis, licensees must collect representative samples for each cannabis production batch to provide to one of the Commission’s licensed ITLs. After samples are collected, the entire production batch must be stored in a secure, cool, and dry location until analytical results are returned by the laboratory ([Sampling and Analysis Protocol 2021](#)).

Ongoing Developments in Cannabis Testing

Cannabis policy is a constantly evolving landscape, and the analytical infrastructure to support cannabis testing also continues to evolve with both industry and legal changes. States regulating cannabis, unlike other agricultural products, do not have federal guidance, federal standards for cannabis testing, or support in establishing standards or other testing protocols. Legalized states have needed to establish regulations to uphold public health and safety in their respective jurisdictions, resulting in a heterogeneous patchwork of testing practices nationwide. Regulatory frameworks for testing include requirements to test cannabis and cannabis-derived products for varied endogenous metabolites and exogenous contaminants such as cannabinoids. Exogenous contaminants include heavy metals, pesticides, microbial contaminants, and residual solvents. The specifics pertaining to testing requirements are different state-to-state dependent on the jurisdictions implementing testing policies and practices (Goldman et al., 2021).

Massachusetts has created a testing infrastructure to ensure practices are aligned with best practices with similar commodities and cannabis testing across the U.S. This work is ongoing and evolves to adapt to varying legal changes and industry trends, as well as innovations in the underlying science.

Cannabinoids

[See Section II. Cannabis Background, subsections: 1) Cannabinoids and 2) Cannabis vs. Hemp for more background information on the distinction between cannabis-derived and hemp-derived cannabinoids]

Massachusetts requires that all products are tested for their [cannabis-derived] cannabinoid profile (i.e., the dry-weight percentages of delta-nine-tetrahydrocannabinol, cannabidiol, tetrahydrocannabinolic acid, and cannabidiolic acid), as well as for contaminants [See Regulations: [935 CMR 500.160\(2\)](#)]. Testing must be performed by a licensed ITL in accordance with sampling and analysis protocols implemented by the Commission for testing finished cannabis and cannabis products and environmental media.

Of note, heat, including combustion, can cause chemical reactions that convert cannabinoids to more or less potent forms. For example, combustion causes non-psychoactive cannabinoid acids to convert to psychoactive forms (e.g., THCA converts to THC). As a result, because

production of finished marijuana products and marijuana-infused products can affect cannabinoid chemistry, each product type must be tested to characterize the cannabinoid content and profile.

[See [Guidance Documents](#) on the Commission website for testing and analysis protocols for cannabis products for MEs and MTCs].

*This report solely uses data from the regulated medical and adult-use cannabis markets and does *not* include hemp-derived cannabinoids, which are not regulated by the Commission.

Potency

The term “THC potency” is interpreted by the Commission as THC concentration because reliable empirical measures for concentration exist. Referencing the Colorado Department of Public Health and Environment’s work, THC concentration is defined as, “THC content per volume or weight of marijuana products, usually measured in milligrams or percentage.”

THC concentration is typically measured in percentage of THC for inhaled products and in milligrams of THC for edible products and infused drinks. Dose or dosage refers to the amount of THC consumed at one time point (Doonan et al., 2021).

Certain types of cannabis products are known to have a higher potency of THC, including concentrates, when compared to bud (“flower”). Therefore, an assessment of product type trends may indicate whether highly potent products (“concentrates”) are increasing in popularity as compared to typically less-highly potent products (“flower”).

Microbial Contaminants and Mycotoxins

Finished plant material, cannabis resin, and cannabis concentrates are tested for microbial contaminants and mycotoxins in production batches to be dispensed as marijuana products. All production batches of cannabis-infused products are tested for microbial contaminants and mycotoxins. Requirements for total viable aerobic bacteria, total yeast and mold, total coliforms, and bile tolerant gram-negative bacteria are given in colony forming unit (CFU) counts per mass of product sample. The requirement for pathogenic *E. coli* and *Salmonella* spp. are based on detection in a one gram sample, and the requirement for mycotoxins is based on the concentration per kilogram of sample ([Sampling and Analysis Protocol 2021](#)).

Literature Review

The cannabis microbiome includes bacteria and fungi residing on the exterior surface of leaves and flowers, called epiphytes, and within the plant tissues, called endophytes. Epiphytic microbes can originate from many sources, such as aerosols, dusts, liquids, or human contact. Endophytes typically enter the plant via the roots. As a result, all sources of microbial inputs are important when considering cannabis growth and consumer safety. While some plant-associated microbes may be neutral or even provide benefits for cultivation through growth stimulation or insect/microbial resistance, some plant-associated microbes may also present risks of infectious illness for human consumers (McKernan et al., 2016).

The American Herbal Pharmacopoeia (AHP) issued specific protocols for microbial testing based on tests for commodity food products issued by the U.S. Environmental Protection Agency (EPA), U.S. Food and Drug Administration (FDA), and assays for cannabis used in Holland. For orally consumed cannabis, the AHP recommended four tests: total yeast and mold count, total coliforms, *Escherichia coli*, and *Salmonella* spp. The AHP proposed specific limits in CFU/g counts but stated that these values were recommended levels when plants are cultivated and harvested under normal circumstances rather than pass-fail criteria (McPartland & McKernan, 2017).

Data

Dataset and Methods

Data were available for the test types “THC (%) Raw Plant Material” (THC), “THCA (%) Raw Plant Material” (THCA), and “Total Yeast and Mold (CFU/g) Raw Plant Material” (TYM) from April 12, 2021, through December 31, 2023. This data is also available on the [Open Data Catalog](#), along with documentation that further explains the structure of the dataset.

THCA is the molecular precursor to THC, and thus THC and THCA potency are often reported together in products as “Total THC.” In November 2023, the Commission began requiring ITLs to use the formula $(\text{THC} + [0.877 \cdot \text{THCA}])$ to calculate Total THC. This formula accounts for the volume lost when THCA decarboxylates to become THC ([Bulletin, Cannabinoid Reporting by ITLs](#)). Another formula commonly used prior to this was $(\text{THC} + \text{THCA})$, which does not account for volume lost in decarboxylation.

A total of 399,135 results were reported in the dataset, with 133,045 results reported for each of the three test types [See Table VIII.1. Reported Results Before Removing Identifiable Nulls (Count), by Test Type and Year]. The number of reported results increased from 83,115 in 2021 (April-December) to 163,419 in 2023.

Table VIII.1. Reported Results Before Removing Identifiable Nulls (Count), by Test Type and Year

Year	THC		THCA		TYM		Total	
	Count	%	Count	%	Count	%	Count	%
2021 ⁺	27,705	6.9%	27,705	6.9%	27,705	6.9%	83,115	20.8%
2022	50,867	12.7%	50,867	12.7%	50,867	12.7%	152,601	38.2%
2023	54,473	13.6%	54,473	13.6%	54,473	13.6%	163,419	40.9%
Total	133,045	33.3%	133,045	33.3%	133,045	33.3%	399,135	100.0%

*Note: ⁺Data for 2021 is available from 4/12/2021- 12/31/2021.

During the study timeframe, MEs were able to send samples to multiple ITLs and have each conduct a different portion of the three required tests. However, Metrc has an upload requirement that requires each ITL to enter numerical results for all required tests each time they report any required test result, even if they did not run all required tests in that instance. For example, a cultivator could send a sample to LabA for TYM but to LabB for THC and THCA. In these instances, ITLs enter a placeholder result of “0” for any tests they did not run and sometimes enter a note in the comment field to indicate that no test was run. This allows data reviewers to differentiate between real test results (e.g. 0% THC or 0 CFU/g TYM) and these placeholder (0 “null”) results. However, since ITLs may not always routinely or consistently enter comments to indicate when a test was not run, the presence of placeholder null results complicates analyses due to reliability and validity concerns. We partly adjusted for this limitation prior to all analyses by removing all identifiable placeholder results in our dataset, as described below. However, because we were only able to remove identifiable placeholder results, an unknown number remain in the dataset.

Prior to our analyses, we excluded 39,547 results where the “TestComment” field contained the text “not test”, “test not”, “not perform”, “no test” (not case sensitive), or “NT” (case sensitive). We also excluded 841 results where the “TestComment” field contained the text “additional sample”, indicating that the test was incomplete, and an additional sample was required. A total of 40,388 results, or 10.1% of the original 399,135, were excluded based on

these criteria [See Table VIII.2. Identifiable Null Test Results Removed (Count), by Test Type and Year]. A plurality (40.7%) of the excluded test results were TYM. We did not filter out results of “0”, because those are possible real test results (e.g. 0% THC or 0 CFU/g for TYM). It is probable that unidentified null results remain, which complicates results from a research perspective—a limitation of using a data repository system which includes both real and unconfirmed null numerical “0” results for research analysis and modeling.

Table VIII.2. Identifiable Null Test Results Removed (Count), by Test Type and Year

Year	THC		THCA		TYM		Total	
	Count	%	Count	%	Count	%	Count	%
2021+	3,615	9.0%	3,615	9.0%	4,688	11.6%	11,918	29.5%
2022	4,357	10.8%	4,357	10.8%	5,861	14.5%	14,575	36.1%
2023	4,012	9.9%	4,013	9.9%	5,870	14.5%	13,895	34.4%
Total	11,984	29.7%	11,985	29.7%	16,419	40.7%	40,388	100.0%

*Note: +Data for 2021 is available from 4/12/2021- 12/31/2021.

Following the removal of identifiable null results, the total number of results reported in the dataset was 358,747 [See Table VIII.3 Reported Results After Removing Identifiable Nulls (Count), by Test Type and Year]. The number of reported results increased from 71,197 in 2021 (April-December) to 149,524 in 2023. All analyses are conducted with identifiable null results removed.

Table VIII.3. Reported Results After Removing Identifiable Nulls (Count), by Test Type and Year

Year	THC		THCA		TYM		Total	
	Count	%	Count	%	Count	%	Count	%
2021+	24,090	6.7%	24,090	6.7%	23,017	6.4%	71,197	19.8%
2022	46,510	13.0%	46,510	13.0%	45,006	12.5%	138,026	38.5%
2023	50,461	14.1%	50,460	14.1%	48,603	13.5%	149,524	41.7%
Total	121,061	33.7%	121,060	33.7%	116,626	32.5%	358,747	100.0%

*Note: +Data for 2021 is available from 4/12/2021- 12/31/2021.

Testing Data Limitations

There are known limitations to the testing data analyzed for this report. Documentation of the testing data, including how it was extracted from Metrc and what is included, is available on the [Open Data Catalog](#). This dataset has limitations, including:

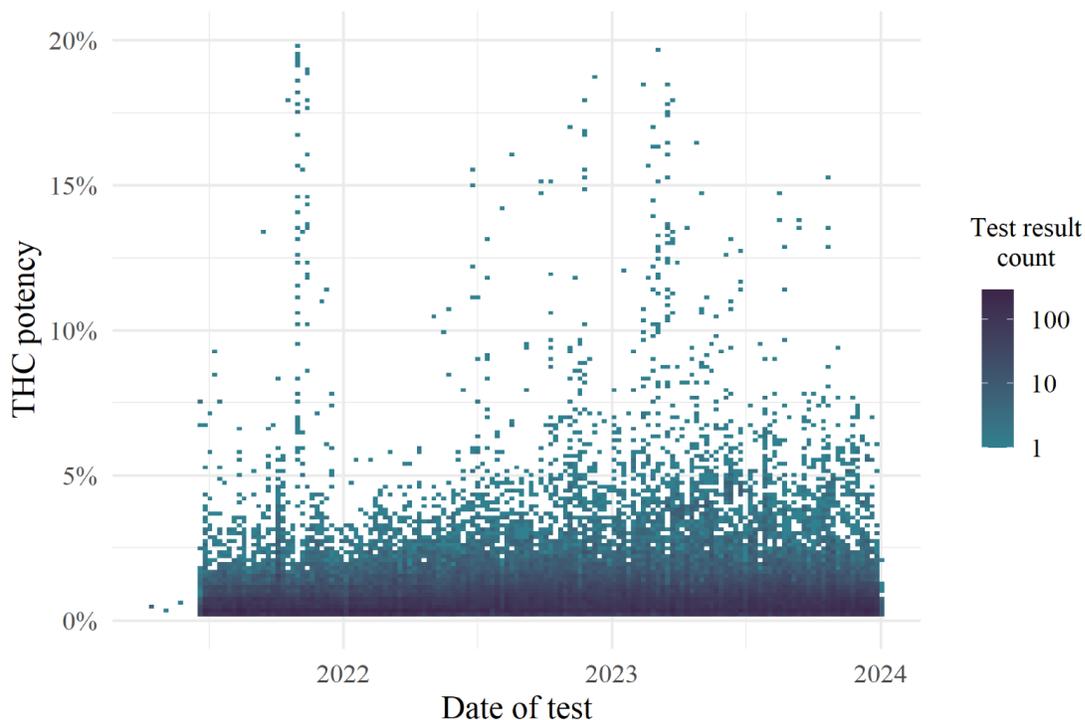
- Testing data is extracted from Metrc “as is” (i.e., as entered by ITLs), and relies on the accuracy of ITLs’ data imputation. Results may include human error, such as data entry inaccuracies (e.g., entering an incorrect number or test type when entering a result).
- ITLs may vary in their data entry procedures, such as in their use of the “TestComment” field.
- ITLs may have applied “dry-weight basis” moisture correction to cannabinoid potency results, which typically adjusts the potency percentage upward to account for the moisture present in the flower sample that will not be present in the final product. The Commission issued a [bulletin](#) in November 2023, followed by a clarification [letter](#) in March 2024, requiring ITLs to report cannabinoid potency results without such correction. However, cannabinoid potency results reported prior to this requirement may have had “dry-weight basis” moisture correction. The available dataset does not contain a field indicating whether this correction was applied, thus, the extent of results entered after the previously permitted moisture correction are unknown.
- As described above, some results of 0% or 0 CFU/g may be placeholder null results that were entered to satisfy Metrc’s upload requirement but could not be identified and removed using the “TestComment” field. The extent of these results is unknown.

Metrc is not used as a research data repository—until the null “0” metric validity and reliability issues are remedied, these descriptive results from testing data may not be accurate for use in research but are helpful for general industry monitoring and understanding next steps in the evolving landscape of cannabis regulation and research. This is a significant data limitation that the Commission is aware of and continues to proactively work to remedy for future analyses and reporting.

Cannabinoid Potency: THC

Reported THC results trended upward from April 2021 to December 2023, from a median value of 0.4% in 2021 to 0.6% in 2023 [See Figure VIII.1. Density Plot of Reported Results for THC Potency (%) and Table VIII.4. Summary Statistics for THC Percentage Test Results, by Year]. The THC percentage in raw plant material is typically low; when the plant is heated, the non-psychoactive cannabinoid acid THCA converts (decarboxylates) into the psychoactive THC. Unexpectedly high reported values for THC can appear for several reasons, including data entry errors, decarboxylation in the sample prior to testing, or potential fraud or manipulation. However, establishing a cause requires more in-depth analysis, including multiple stakeholder collaboration and specific content and methodological expertise. Additionally, cannabinoid potency would also vary across product types – a concentrate would be much more potent than flower, for example. This dataset contains results reported for raw plant material (i.e., post-harvest and prior to any product manufacturing).

Figure VIII.1. Density Plot of Reported Results for THC Potency (%)



*Note: The plot includes THC results that are less than or equal to 20%, which comprise 99.97% of 121,061 total results.

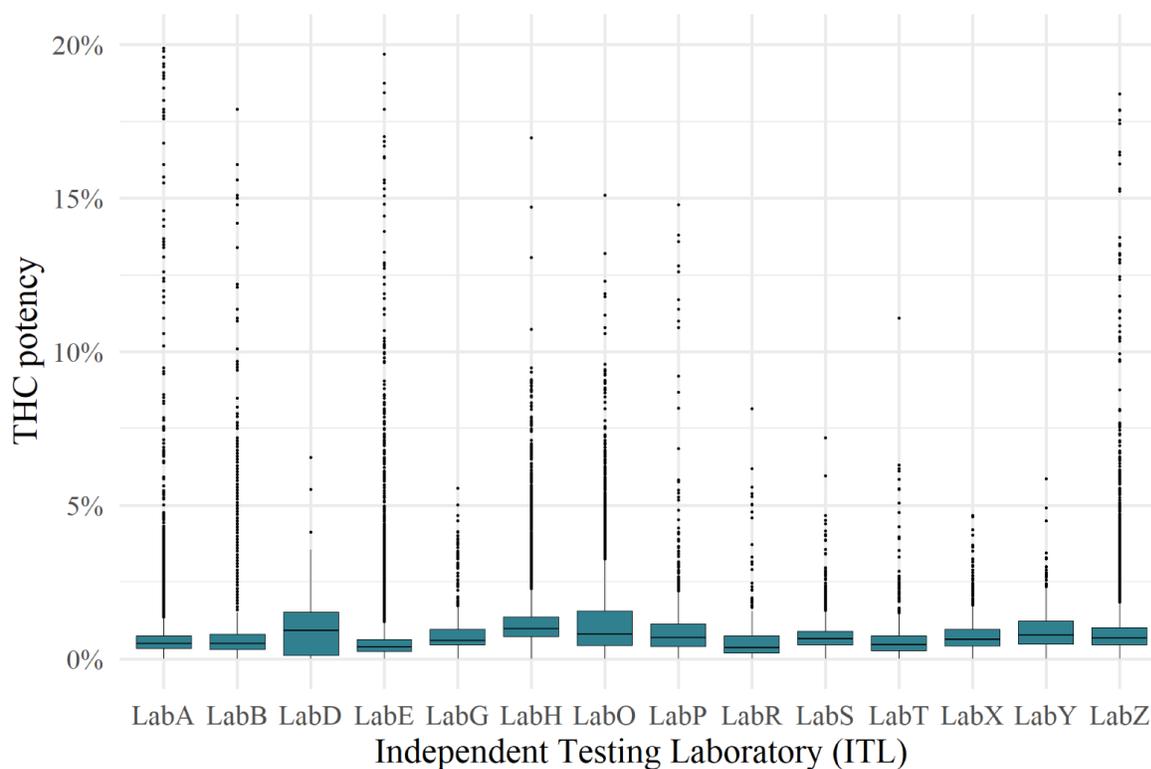
Table VIII.4. Summary Statistics for THC Percentage Test Results, by Year

Year	Count	Min.	1st Quartile	Median	Mean	3rd Quartile	Max.
2021 ⁺	24,090	0.0%	0.3%	0.4%	0.6%	0.7%	29.9%
2022	46,510	0.0%	0.3%	0.5%	0.7%	0.9%	39.4%
2023	50,461	0.0%	0.3%	0.6%	0.8%	1.0%	83.1%

*Note: ⁺Data for 2021 is available from 4/12/2021- 12/31/2021.

Reported THC results varied by ITL, from a median of 0.3% for LabC from two test results to a median of 1.1% for LabF from 40 results. Among labs with at least 100 tests run, the lowest median was 0.4% (LabE and LabR) and the highest was 1.0% (LabH) [See Figure VIII.2. Box-and-Whisker Plot of Reported THC Results, by ITL and Table VIII.5. Summary Statistics for THC Percentage Test Results, by ITL].

Figure VIII.2. Box-and-Whisker Plot of Reported THC Results, by ITL



*Note: The plot includes THC results that are less than or equal to 20%, which comprise 99.97% of 121,061 total

results. LabC and LabF are not included in the plot due to their low number of reported results (2 results for LabC and 40 results for LabF). The boxplots display the minimum value (lowermost point or end of the vertical line); first quartile (lower end of the box); median (horizontal line running through the box); third quartile (upper end of the box); and maximum value (uppermost point or end of the vertical line).

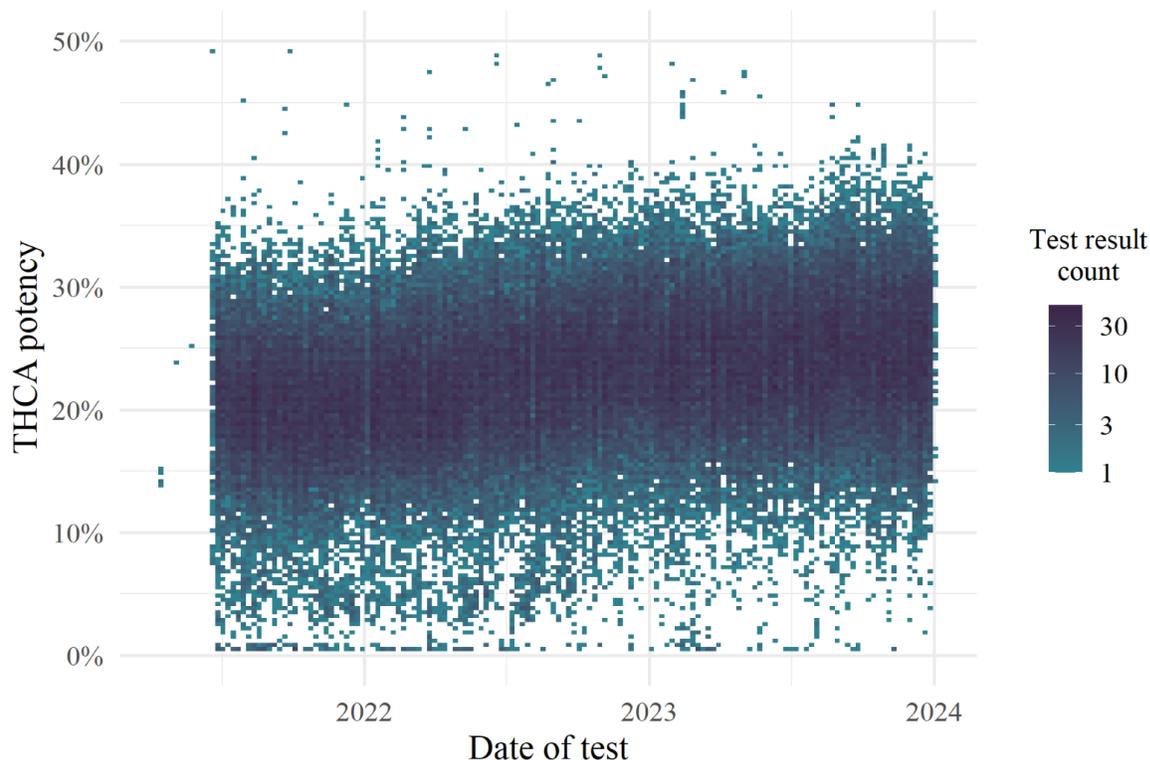
Table VIII.5. Summary Statistics for THC Percentage Test Results, by ITL

ITL	Count	Min.	1st Quartile	Median	Mean	3rd Quartile	Max.
LabA	23,794	0.0%	0.3%	0.5%	0.7%	0.7%	29.9%
LabB	33,452	0.0%	0.3%	0.5%	0.7%	0.8%	27.7%
LabC	2	0.2%	0.2%	0.3%	0.3%	0.3%	0.3%
LabD	234	0.0%	0.1%	0.9%	1.0%	1.5%	6.6%
LabE	29,778	0.0%	0.2%	0.4%	0.6%	0.6%	26.0%
LabF	40	0.0%	0.8%	1.1%	1.5%	2.0%	7.8%
LabG	555	0.0%	0.5%	0.6%	1.1%	1.0%	56.1%
LabH	13,250	0.0%	0.7%	1.0%	1.2%	1.4%	28.0%
LabO	3,801	0.0%	0.4%	0.8%	1.3%	1.6%	29.2%
LabP	1,697	0.0%	0.4%	0.7%	1.0%	1.1%	14.8%
LabR	427	0.0%	0.2%	0.4%	0.8%	0.7%	83.1%
LabS	1,572	0.0%	0.5%	0.7%	0.8%	0.9%	7.2%
LabT	1,074	0.0%	0.3%	0.5%	0.6%	0.8%	11.1%
LabX	1,220	0.0%	0.4%	0.6%	0.8%	1.0%	4.7%
LabY	499	0.0%	0.5%	0.8%	1.0%	1.2%	5.9%
LabZ	9,666	0.0%	0.5%	0.7%	0.9%	1.0%	39.4%

Cannabinoid Potency: THCA

Reported THCA results trended upward from April 2021 to December 2023, from a median value of 20.2% in 2021 to 24.1% in 2023 [See Figure VIII.3. Density Plot of Reported Results for THCA Potency (%) and Table VIII.6. Summary Statistics for THCA Percentage Test Results, by Year].

Figure VIII.3. Density Plot of Reported Results for THCA Potency (%)



*Note: The plot includes THCA results that are less than or equal to 50%, which comprise 99.98% of 121,060 total results.

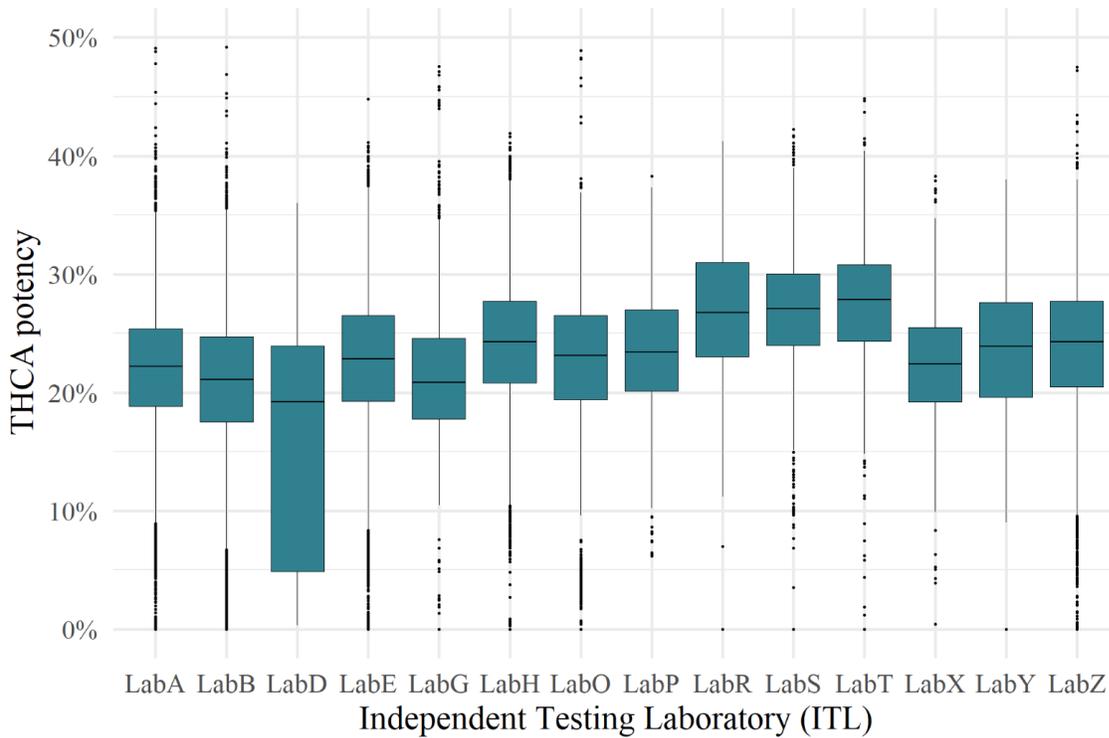
Table VIII.6. Summary Statistics for THCA Percentage Test Results, by Year

Year	Count	Min.	1st Quartile	Median	Mean	3rd Quartile	Max.
2021 ⁺	24,090	0.0%	16.9%	20.2%	19.9%	23.4%	53.1%
2022	46,510	0.0%	18.6%	22.2%	22.0%	25.7%	73.9%
2023	50,460	0.0%	20.6%	24.1%	24.0%	27.6%	82.5%

*Note: ⁺Data for 2021 is available from 4/12/2021- 12/31/2021.

Reported THCA results varied by ITL, from a median of 19.2% for LabD to a median of 27.8% for LabT [See Figure VIII.4. Box-and-Whisker Plot of Reported THCA Results, by ITL and Table VIII.7. Summary Statistics for THCA Percentage Test Results, by ITL].

Figure VIII.4. Box-and-Whisker Plot of Reported THCA Results, by ITL



*Note: The plot includes THCA results that are less than or equal to 50%, which comprise 99.98% of 121,060 total results. LabC and LabF are not included in the plot due to their low number of reported results (2 results for LabC and 39 results for LabF). The boxplots display the minimum value (lowermost point or end of the vertical line); first quartile (lower end of the box); median (horizontal line running through the box); third quartile (upper end of the box); and maximum value (uppermost point or end of the vertical line).

Table VIII.7. Summary Statistics for THCA Percentage Test Results, by ITL

ITL	Count	Min.	1st Quartile	Median	Mean	3rd Quartile	Max.
LabA	23,794	0.0%	18.8%	22.2%	22.0%	25.4%	50.2%
LabB	33,452	0.0%	17.5%	21.1%	20.8%	24.7%	73.9%
LabC	2	18.7%	19.3%	19.9%	19.9%	20.4%	21.0%
LabD	234	0.3%	4.8%	19.2%	16.6%	24.0%	36.0%
LabE	29,778	0.0%	19.3%	22.8%	22.8%	26.5%	57.8%
LabF	39	0.0%	23.2%	26.4%	25.4%	28.5%	37.7%
LabG	555	0.0%	17.8%	20.8%	21.9%	24.6%	47.6%
LabH	13,250	0.0%	20.8%	24.3%	24.2%	27.7%	52.1%
LabO	3,801	0.0%	19.4%	23.1%	22.3%	26.5%	55.2%
LabP	1,697	6.2%	20.1%	23.4%	23.4%	27.0%	38.3%
LabR	427	0.0%	23.0%	26.7%	26.7%	31.0%	41.3%
LabS	1,572	0.0%	24.0%	27.1%	26.8%	30.0%	82.5%
LabT	1,074	0.0%	24.3%	27.8%	27.5%	30.8%	44.9%
LabX	1,220	0.4%	19.2%	22.4%	22.4%	25.5%	38.3%
LabY	499	0.0%	19.7%	23.9%	23.3%	27.7%	53.0%
LabZ	9,666	0.0%	20.4%	24.3%	23.9%	27.7%	47.5%

Microbial Contamination: Total Yeast and Mold

TYM measures the total quantity of yeasts and molds on the sample in “colony forming units” per gram (CFU/g). TYM is a separate test from those measuring the quantity or presence of specific yeasts or molds. The regulatory cutoff value for this test is 10,000 CFU/g. Results less than or equal to 10,000 CFU/g pass; results greater than this value fail.

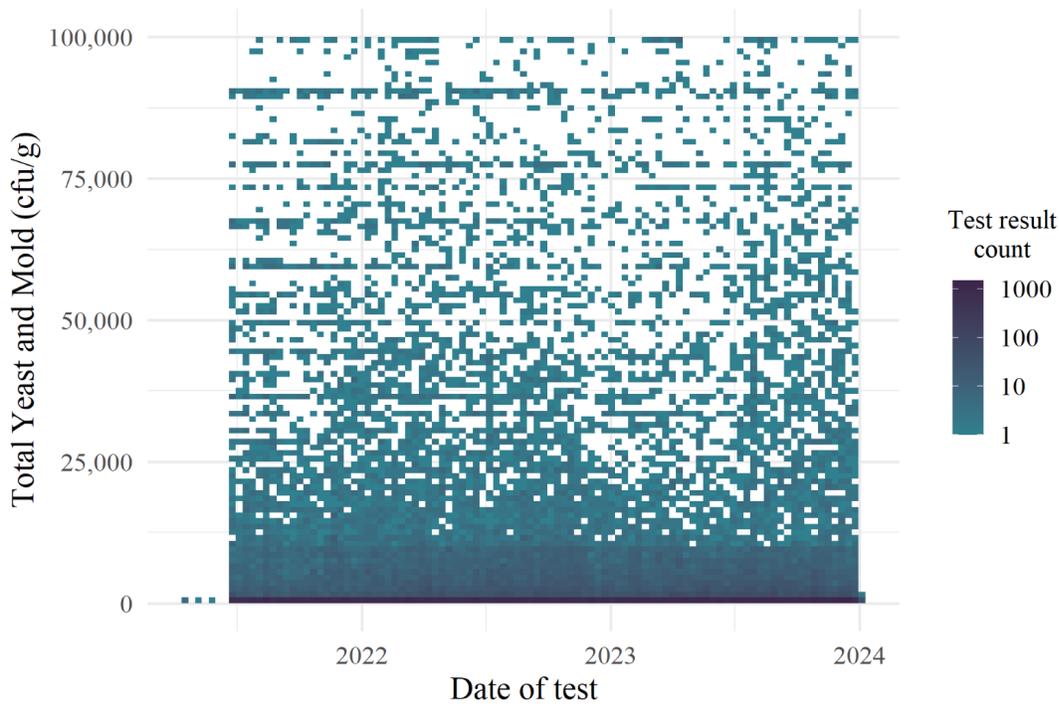
116,626 TYM test results were reported from April 2021 to December 2023. There were 10,457 (9.0%) failing results and 106,169 (91.0%) passing results, with the overall failure rate decreasing from 10.0% in 2021 to 7.5% in 2023 [See Table VIII.8. TYM Pass and Fail Rates, by Year and Figure VIII.5. Density Plot of Reported Results for TYM]. The majority of results reported each year (67.2% across all three years) were 0 CFU/g.

Table VIII.8. TYM Pass and Fail Rates, by Year

Year	Pass ⁺		Fail		Total			
	0 CFU/g	> 0 CFU/g	Count	% ⁺⁺	Count	% ⁺⁺	Count	% ⁺⁺
2021 ⁺	15,964	69.4%	4,751	20.6%	2,302	10.0%	23,017	100.0%
2022	29,169	64.8%	11,312	25.1%	4,525	10.1%	45,006	100.0%
2023	33,220	68.3%	11,753	24.2%	3,630	7.5%	48,603	100.0%
Total	78,353	67.2%	27,816	23.9%	10,457	9.0%	116,626	100.0%

*Note: ⁺Data for 2021 is available from 4/12/2021- 12/31/2021. Passing results (those less than or equal to 10,000 CFU/g) are divided into two categories: 0 CFU/g and greater than 0 CFU/g. ⁺⁺Percentages are calculated based on row totals.

Figure VIII.5. Density Plot of Reported Results for TYM



*Note: The plot includes TYM results that are less than or equal to 100,000 CFU/g (97.1% of 116,626 results).

The TYM failure rate varied by ITL, from 0.0% for LabC and LabF (for 2 results and 40 results, respectively) to 16.4% for LabB. Among labs with at least 100 tests run, the lowest failure rate was 0.3% for LabS [See Table VIII.9. TYM Pass and Fail Rates, by ITL]. ITLs also varied in the distribution of their reported passing results: LabA and LabS reported no passing results greater than 0 CFU/g, while LabC and LabD reported no results of 0 CFU/g.

Table VIII.9. TYM Pass and Fail Rates, by ITL

ITL	Pass ⁺		Fail		ITL Total			
	= 0 CFU/g	> 0 CFU/g	Count	% ⁺⁺	Count	% ⁺⁺	Count	%
LabA	22,149	94.8%	0	0.0%	1,211	5.2%	23,360	100.0%
LabB	15,975	52.3%	9,544	31.3%	5,006	16.4%	30,525	100.0%
LabC	0	0.0%	2	100.0%	0	0.0%	2	100.0%
LabD	0	0.0%	213	91.4%	20	8.6%	233	100.0%
LabE	22,077	75.8%	5,483	18.8%	1,568	5.4%	29,128	100.0%
LabF	33	82.5%	7	17.5%	0	0.0%	40	100.0%
LabG	424	85.0%	56	11.2%	19	3.8%	499	100.0%
LabH	8,656	65.2%	3,150	23.7%	1,461	11.0%	13,267	100.0%
LabO	1,855	49.3%	1,551	41.2%	359	9.5%	3,765	100.0%
LabP	1,126	65.3%	425	24.6%	174	10.1%	1,725	100.0%
LabR	143	33.3%	233	54.2%	54	12.6%	430	100.0%
LabS	1,567	99.7%	0	0.0%	4	0.3%	1,571	100.0%
LabT	456	43.3%	449	42.6%	149	14.1%	1,054	100.0%
LabX	1,004	83.3%	89	7.4%	113	9.4%	1,206	100.0%
LabY	193	38.7%	291	58.3%	15	3.0%	499	100.0%
LabZ	2,695	28.9%	6,323	67.8%	304	3.3%	9,322	100.0%
Grand Total	78,353	67.2%	27,816	23.9%	10,457	9.0%	116,626	100.0%

*Note: ⁺Passing results (those less than or equal to 10,000 CFU/g) are divided into two categories: 0 CFU/g and greater than 0 CFU/g. ⁺⁺ Percentages are calculated based on row totals.

Heavy Metals

Data were not available for analysis for this test type as of April 2024.

Toxic elements with densities greater than 5 g/cm³ and atomic numbers higher than 11 are traditionally referred to as heavy metals. These elements include arsenic, cadmium, lead, and

mercury (Goldman et al., 2021). Heavy metal contamination is harmful to humans due to the ability of heavy metals to accumulate in the body and potentially cause future illness (Järup, 2003; Munir et al., 2021).

In Massachusetts, finished plant material is tested for heavy metals in production batches that are to be dispensed as marijuana product, and all production batches of cannabis resin and cannabis concentrates are tested for heavy metals. Heavy Metal analysis is conducted for the following four metals with upper limits for "all uses" and "ingestion only": Arsenic, Cadmium, Lead, and Mercury. A production batch of finished marijuana products may only be dispensed to patients if all four of the metals are below the upper limits for the respective product and intended use (e.g., ingestion only or all other uses). These limits are in micrograms (μg) of contaminant per kilogram (kg) of product ([Sampling and Analysis Protocol 2021](#)).

Literature Review

As heavy metals are harmful to human biological systems, it is essential that these contaminants are minimized in cannabis produced for human consumption (Jaishankar et al., 2014; Järup, 2003; Munir et al., 2021). One major factor to consider in this is that cannabis is particularly efficient at absorbing heavy metals from soil. While this propensity makes cannabis an effective bioremedial plant – a plant used to extract pollutants from soil – it also means that pollutants more easily accumulate in cannabis tissues (McParland and McKernan, 2017). Metals can contaminate soils for multiple reasons including industrial manufacturing runoff, direct application of fertilizers and pesticides, application of animal wastes or sludges, and atmospheric deposition of metal-containing particulate matter, as well as through ash from wildfires and volcanic eruptions (Goldman et al., 2021).

Heavy metal accumulations are a point of concern when assessing potential health impacts associated with the use of vape products. Factors including time, device composition, temperature, and usage may potentially lead to the leaching of heavy metals into vape products (Gonzalez-Jimenez et al., 2021); However, there is currently insufficient scientific information to better inform definitive evidence-based policy on vape products and heavy metals. As a conservative mechanism to best protect consumers, all potential contributing factors that may impact the leaching of metals into vape products continue to be monitored and investigated by the Commission, and licensees are required to conduct a second heavy

metal screening on all finished vape products subject to the First Amended Quarantine Order ([Sampling and Analysis Protocol 2021](#)).

Pesticides and Plant Growth Regulators

Data were not available for analysis for this test type as of April 2024.

MDAR has primary jurisdiction over pesticides. Non-organic pesticides are prohibited and may not be used to cultivate cannabis in Massachusetts. Per 935 CMR 500.120(5) and 935 CMR 501.120(5), application of pesticides shall be performed in compliance with M.G.L. c. 132B and the regulations promulgated at 333CMR 2.00 –14.00 by MDAR. All cannabis flower must be tested for pesticides in the flower stage whether the flower will be sold and consumed as-is or will be further processed into additional products ([State of Cannabis in Massachusetts 2023](#)).

Literature Review

Pesticides are compounds that are manufactured to destroy insects or microorganisms that can harm plants. Pesticides are generally categorized by their class of use or chemical class. The classes of use include insecticides, fungicides, herbicides, rodenticides, acaricides, nematocides, and molluscicides. Pesticide chemical class's dominant groups include organophosphorus compounds, pyrethroids, chlorinated hydrocarbons, carbamates, and heterocyclic compounds (Goldman et al., 2021).

The UPS, which sets national quality, purity, strength, and identity standards for medicines, food ingredients, and dietary supplements, lists 108 pesticides for which consumable crops should be tested. Although there are a high number of analytes, there is a lack of federal guidance on which residues to look for in cannabis, as well as a lack of toxicological and environmental data. These complexities have resulted in states having little guidance for determining how to regulate pesticide use for legal cannabis and cannabis products. A 2013 release by the AHP included pesticides that were most likely used on cannabis and highlighted acaricides, insecticides, fungicides, and plant growth regulators. However, variation between state testing policies and practices is common, as little is known about best practices of pesticide application and use in cannabis cultivation due to its Schedule I federal status (Goldman et al., 2021).

Acknowledging that no method currently exists that analyzes all registered pesticides efficiently, Commission guidance refers to the USDA “target” analyte list of 195 prohibited pesticides, in which pesticide testing should be performed consistent with sections NOP 2611 and 2613 of the National Organic Program Handbook: Guidance and Instructions for Accredited Certifying Agents and Certified Operations ([Sampling and Analysis Protocol 2021](#)).

Residual Solvents

Data were not available for analysis for this test type as of April 2024.

All production batches of cannabis resin and cannabis concentrates are tested for residual solvents (if applicable). Testing upper limits are based on residual solvent standards provided by the USP, the International Conference on Harmonization, and AHP. Consistent with the standards provided by these sources, “Class 1” solvents including benzene, carbon tetrachloride, 1,2- dichloroethane, 1,1- dichloroethene, and 1,1,1-trichloroethane may not be used in the production of any marijuana product ([Sampling and Analysis Protocol 2021](#)).

Literature Review

Published residual solvent test regulations often reference USP, which is considered a gold standard for pharmaceutical products. The testing methods described in USP for common solvents that are present in drug substances, excipients, and finished products have been implemented for decades. Unlike pharmaceuticals, cannabis product manufacturing uses compounds such as propane, butane, and isobutane during the extraction process, which some researchers believe requires a more expanded scope. Due to its current Schedule I status, unified and standardized safety measures used at the federal level are not applied to cannabis, which results in a lack of standardization across states for residual solvent testing (Goldman et al., 2021).

Vitamin E Acetate

Data were not available for analysis for this test type as of April 2024.

Vitamin E Acetate (VEA) is tested for in cannabis resin and cannabis concentrate vaporizer products in production batches that are to be dispensed as marijuana product. Licensees who produce and/or sell vaporizer products must send vaporizer products that have been pre-filled (final ready-to-sell form) with cannabis oil to one of the Commission's ITLs for VEA and a second heavy metal screen. Additional Guidance on VEA Testing can be found in the First and Second Amended Order Applying to Vaporizer Products ([State of Cannabis in Massachusetts 2023](#)).

EVALI Crisis

Although the Commission implements comprehensive public health regulations and testing protocols to ensure the safety of cannabis products in the regulated markets, products sold on the unregulated market remain untested. This can result in public health concerns or crises, most notably, the e-cigarette or vaping use-associated lung injury (EVALI) crisis, which began in 2019 with an outbreak of severe vaping-associated pulmonary illness and injuries. The Center for Disease Control (CDC) reported that as of February 18, 2020, a total of 2,807 hospitalized e-cigarette, or vaping, product use-associated EVALI cases or deaths were reported from 50 states, the District of Columbia, and two U.S. territories (Puerto Rico and U.S. Virgin Islands) (Centers for Disease Control and Prevention (CDC), 2020). In Massachusetts, the Governor declared a public health emergency, the DPH temporarily banned the sale of nicotine and cannabis vaping products and devices, and the Commission exercised its authority to quarantine products while it put in place additional testing requirements to ensure the safety of products sold through the regulated market.

The CDC identified VEA, a substance used to dilute THC primarily in unregulated and counterfeit vape products, as strongly linked to the EVALI outbreak (Commonwealth of Massachusetts, 2020). VEA typically does not cause harm when ingested as a vitamin supplement or applied to the skin, but previous research suggests that the inhalation of VEA may interfere with normal lung functioning. VEA was found in product samples tested by FDA and state laboratories and in patient lung fluid samples tested by the CDC from geographically diverse states. VEA was not found in the lung fluid of people without EVALI (Centers for Disease Control and Prevention (CDC), 2020). While results from tests ordered by the Commission showed that no licensed vape product tested positive for VEA, the Commission continues to require mandatory VEA testing on final, ready-to-sell vape products ([Sampling and Analysis Protocol 2021](#)). Additionally, the Commission undertook a [public awareness campaign](#) to remind constituents of the risks of consuming unregulated

vaping products and the importance of checking product labels.

Summary

Available testing data shows a nominal increase over time in reported cannabinoid potency (Total THC), and a similar decrease in failure rates for microbial contamination (Total Yeast and Mold or “TYM”). Although ITLs have varied in their procedures, using different formulas to report Total THC and reporting TYM results to varying degrees of specificity, the Commission has determined a formula which will help labs ensure better metric reliability for data input and future quantitative assessments, allowing researchers to follow patterns more closely. The Commission continues to apply best testing practices as both the science on cannabis testing and regulation continues to evolve.

IX. Data: Agents, Access, and Equity

Agents

The Commission’s Research Department extracted all regulated cannabis market agent data, including all demographic information, from registration forms submitted to the agency prior to employment at Massachusetts cannabis facilities (N = 20,753) as of June 30, 2023. All analyses of descriptive statistics were conducted in R using the “psych” package (Revelle, 2024)

The unit of analysis for agents is primarily individual-level (*i.e. agent registration-level*). Agent registrations account for roles, including board members, directors, employees, executives, managers, and volunteers.

The exceptions to this unit of analysis are in assessing diversity in ownership (DIO) at the business-level [See Table IX.5. Establishments that have Commenced Operations (Count), by Application Review Category and Table IX.6. DBE Establishments that have Commenced Operations (Count), by DBE Category]. “Agent” refers to a registered board member, director, employee, executive, manager, or volunteer of an ME or MTC. Employees include consultants or contractors who provide on-site services to an ME or MTC related to the cultivation, harvesting, preparation, packaging, storage, testing, or dispensing of cannabis. One individual can have multiple agent registrations (“roles”) across the medical and adult-use industry markets. The analyses in this section show the number of ME and MTC “roles” currently employed by Commission-licensed businesses, rather than the exact number of agents, due to how this data is collected. This may result in discrepancies with the number of agents in some instances, such as when an individual works at more than one establishment and therefore may hold multiple registrations with the state.

We include only those agents working under a license that is either “Active” or “Incomplete”, and those with a license application that is either “Approved”, “Pending”, or “Reopened.”

Census

We include basic demographic data derived from the Vintage 2023 U.S. Census Bureau population estimates for Massachusetts to better conceptualize findings within the larger workforce and demographic context of the state as a whole. This dataset supplies

demographic information for the Commonwealth as of July 1, 2023. At the time of survey, an estimated 7,001,394 persons lived in Massachusetts, with 51% of persons identifying themselves as female.

A methodological difference must be noted between how the Commission and the Census Bureau collect and organize data on individuals that identify as Hispanic or Latino. Where the Census Bureau asks respondents to report race and Hispanic/Latino identity separately, the Commission asks respondents to report all of their race/ethnic identities in one question, and to identify which is their primary race/ethnic identity in another. For example, a person who identifies as White and Hispanic/Latino would report these separately in the Census but would choose either “White” or “Hispanic/Latino” as their primary race/ethnicity for the Commission agent dataset. This methodological difference ought to be considered as it may result in some key differences in how demographic statistics are calculated.

As of the 2023 U.S. Census, the largest race group in Massachusetts was 69.6% “White, not Hispanic or Latino”, followed by “Black or African American” (9.5%), “Asian” (7.7%), “American Indian and Alaska Native” (0.5%), and “Native Hawaiian or Other Pacific Islander” (0.1%). About 2.7% of respondents identified themselves as belonging to “Two or More Races.” By origin, 13.1% of the population identify as being of Hispanic or Latino origin across all races.

Agent Registrations

“Volunteer” roles accounted for just 0.78% of the final dataset ($n = 163$) and were omitted from our analyses. We also removed a small portion of observations for which the specific role was not reported (0.43%; $n = 90$). These exclusions left us with a final sample of 20,753 after omissions. This is a fourfold increase over the 4,883 [roles/agents] observed by Doonan et al (2021).

Six distinct roles were reported in total, but for clarity in reporting, we collapse these roles into either senior-level or entry-level roles. For our analyses, Board members (1.86%; $n = 385$), Directors (2.57%; $n = 533$), Executives (4.39%; $n = 912$), and Managers (7.78%; $n = 1,614$) are all designated as “Senior-level” roles within the industry, as opposed to entry-level “General” employees (83.4%; $n = 17,309$) [See Table IX.1 Total Agents in Each Role Category]. Across both General and Senior roles, most agents were registered as ME or MTC Agents (98.36%; $n = 20,412$) in contrast to Laboratory Agents (1.64%; $n = 341$).

Table IX.1 Total Agents in Each Role Category

Role Level	Specific Role	Laboratory Agents	Marijuana Establishment Agents	Total	Percent
Senior	Board member	8	377	385	1.9%
	Director	11	522	533	2.6%
	Executive	21	891	912	4.4%
	Manager	17	1,597	1,614	7.8%
	Total	57	3,387	3,444	16.6%
General	Employee	284	17,025	17,309	83.4%
	Total	341	20,412	20,753	100.0%

Race and Ethnicity

Agents were able to select from several different races/ethnicities and/or write in their own and were prompted to select which of those reported was their “main” race/ethnicity (see *Census Data* section for more information). We group responses as “Other Race/Ethnicity” before further stratification in cases where a race/ethnic group was reported by a small sample size ($n < 10$) to preserve agents’ anonymity [See Table IX.2. Race and Ethnicity: All Agent Registrations for a table of all agents stratified by race/ethnicity].

Across all positions, 69.78% ($n = 14,482$) identified primarily as “White.” The next largest races/ethnicities reported in singularity were “Hispanic, Latino or Spanish” with 8.77% of respondents ($n = 1,820$) and “Black or African American” with 6.62% of respondents ($n = 1,374$). Individuals of “Asian” descent made up 1.95% of respondents ($n = 405$). A race or ethnicity outside of those mentioned was reported by 1.51% ($n = 314$) of respondents. We also note that a fairly large portion of respondents, about 11.36% of observations ($n = 2,358$), reported “Decline to Answer.”

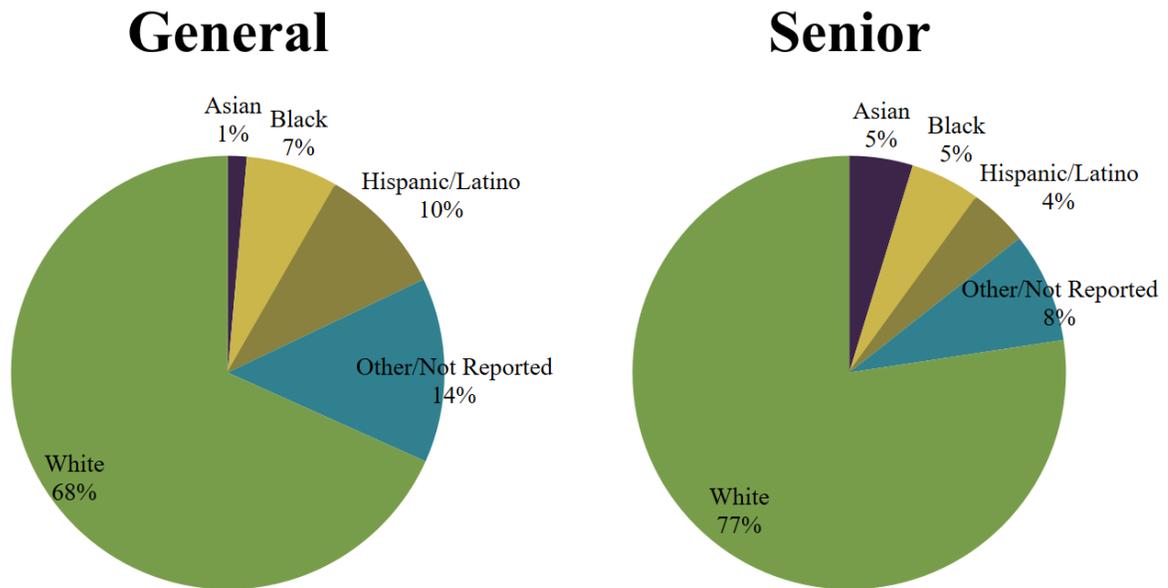
Table IX.2. Race and Ethnicity: All Agent Registrations

Race/Ethnicity (Group)	Race/Ethnicity	Total	(%)
Asian		405	2.0%
Black or African American		1,374	6.6%
Declined to answer		2,358	11.4%
Hispanic, Latino, or Spanish		1,820	8.8%
Other Race/Ethnicity	American Indian or Alaska Native	37	0.2%
	Middle Eastern or North Africa	60	0.3%
	Native Hawaiian or Other Pacific Islander	31	0.1%
	Some Other Race or Ethnicity	186	0.9%
	Total	314	1.5%
White		14,482	69.8%
Total		20,753	100.0%

*Note: [See Appendix Table XI.4. Race and Ethnicity Definitions for full list of definitions as recorded in Massachusetts Open Data]

Among Employees (N = 17,309), 68.3% identified themselves as primarily White (n = 11,816), 9.64% identified as primarily Hispanic/Latino (1,669), 6.9% identified as primarily Black/African American (n = 1,193), and 1.4% identified as primarily Asian (n = 242) [See Figure IX.1. Race and Ethnicity Among Employees and Senior Level Roles]. Individuals that reported a singular race or ethnicity not listed above made up 1.4% (n = 235) of General Employees. We also note that 12.4% of respondents at the General Employee level (n = 2,140) did not report a race and/or ethnicity.

Figure IX.1. Race and Ethnicity Among Employees and Senior Level Roles



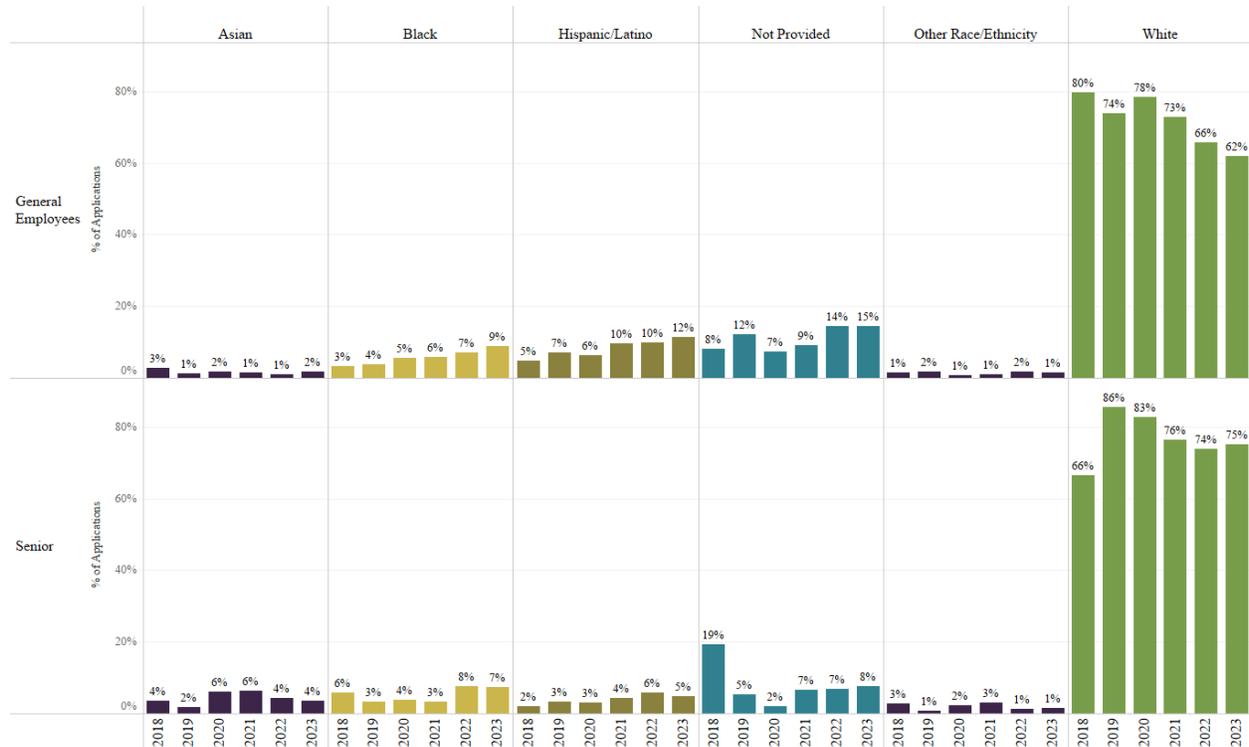
Within the Senior-level agent population (N = 3,444), 77.4% of agents identified as primarily White (n = 2,590), 5.3% identified as primarily Black/African American (n = 181), 4.7% identified as primarily Asian (n = 163), and 4.4% identified as primarily Hispanic/Latino (n = 151). 1.9% of Senior-level agents identified as a singular race/ethnicity not listed above (n = 65). We again observed that many individuals declined to report a race/ethnicity, amounting to about 6.3% (n = 218) of Senior-level agents.

The racial and ethnic makeup of agents also show some trends when viewed by the year of application submission. For instance, among agent applications in 2019, the first full-year of adult-use cannabis implementation in Massachusetts, white individuals made up 74% of General Employee registrations (n = 698) and 86% of Senior-level registrations (n = 339) [See Figure IX.2. Race and Ethnicity of Agent Registrations, by Year of Application Submission and Table IX.3. Race and Ethnicity of General Employees and Senior Level Roles, by Year of Application Submission].

In this same year, Black/African American individuals made up just 4% of General Employees (n = 36) and 3% (n = 13) of Senior-level registrations, and Hispanic/Latino individuals made up 7% of General (n = 67) and 3% (n = 13) of Senior-level registrations. Percentages were noticeably different in 2023, with White individuals making up 62% of

General Employees ($n = 2,443$) and 75% of Senior-level agents ($n = 364$); Black/African American individuals making up 9% of General ($n = 350$) and 7% of Senior-level agents ($n = 36$); and Hispanic/Latino individuals making up 12% of General Employees ($n = 454$) and 5% of Senior agents ($n = 24$).

Figure IX.2. Race and Ethnicity of Agent Registrations, by Year of Application Submission



*Note: [See Appendix Table XI.4. Race and Ethnicity Definitions for full list of definitions as recorded in Massachusetts Open Data]

Table IX.3. Race and Ethnicity of General Employees and Senior Level Roles, by Year of Application Submission

Year of Submission	Main Race/Ethnicity	General Employees		Senior Level	
		<i>n</i>	% of Total	<i>n</i>	% of Total
2018	Asian	<10	2.8%	<10	3.6%
	Black	<10	3.3%	<10	5.7%
	Hispanic/Latino	10	4.7%	<10	2.1%
	Not Provided	17	8.1%	27	19.3%
	Other				
	Race/Ethnicity	<10	1.4%	<10	2.9%
	White	168	79.6%	93	66.4%
2019	Asian	13	1.4%	<10	1.8%
	Black	36	3.8%	13	3.3%
	Hispanic/Latino	67	7.1%	13	3.3%
	Not Provided	115	12.2%	21	5.3%
	Other				
	Race/Ethnicity	16	1.7%	<10	0.8%
	White	698	73.9%	339	85.6%
2020	Asian	27	1.7%	40	6.2%
	Black	86	5.5%	24	3.7%
	Hispanic/Latino	101	6.4%	20	3.1%
	Not Provided	114	7.2%	13	2.0%
	Other				
	Race/Ethnicity	11	0.7%	14	2.2%
	White	1236	78.5%	536	82.8%
2021	Asian	55	1.4%	51	6.4%
	Black	234	6.0%	26	3.2%
	Hispanic/Latino	377	9.6%	35	4.4%
	Not Provided	354	9.0%	53	6.6%
	Other				
	Race/Ethnicity	44	1.1%	24	3.0%
	White	2858	72.9%	614	76.5%
2022	Asian	74	1.1%	43	4.4%
	Black	480	7.2%	74	7.6%

	Hispanic/Latino	660	9.8%	56	5.8%
	Not Provided	966	14.4%	67	6.9%
	Other				
	Race/Ethnicity	118	1.8%	13	1.3%
	White	4413	65.8%	720	74.0%
2023	Asian	67	1.7%	17	3.5%
	Black	350	8.9%	36	7.4%
	Hispanic/Latino	454	11.5%	24	4.9%
	Not Provided	574	14.6%	37	7.6%
	Other				
	Race/Ethnicity	57	1.4%	<10	1.4%
	White	2443	61.9%	364	75.0%

*Note: [See Appendix Table XI.4. Race and Ethnicity Definitions for full list of definitions as recorded in Massachusetts Open Data]

Gender

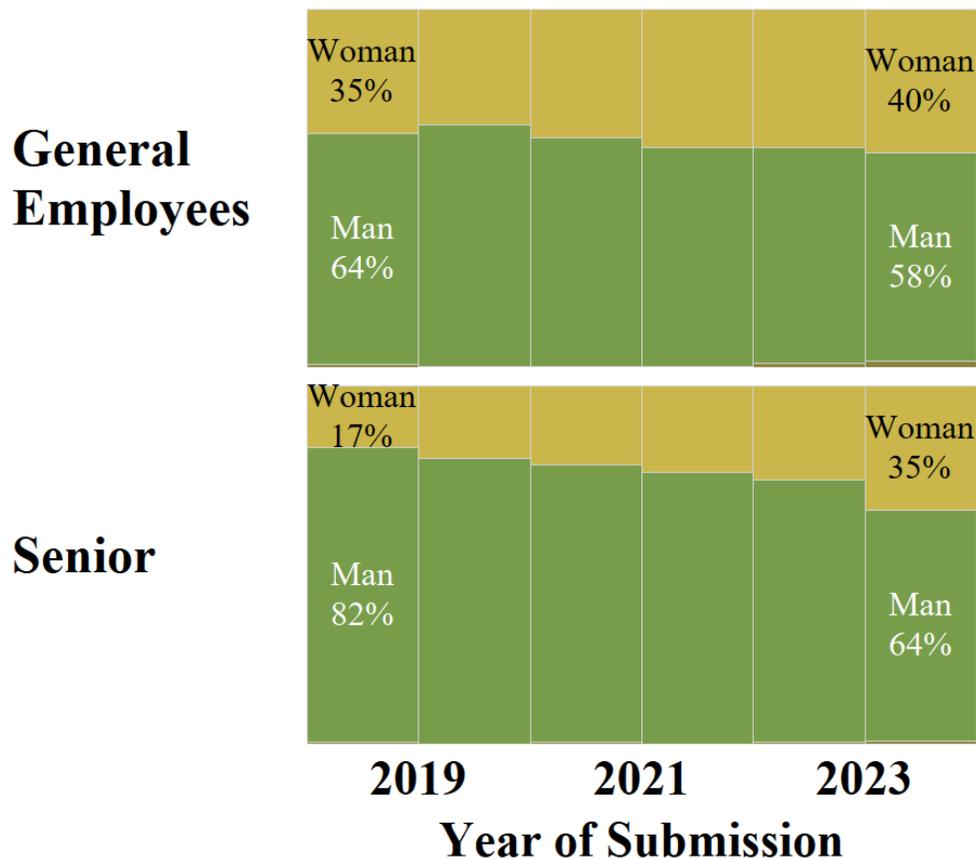
Agents were given the option to either select from one of three response options (“Male”, “Female”, or “Decline to Answer”) or write in their own. Among all employees, 63% of agents ($n = 13,074$) identified as men, and 36.1% ($n = 7,489$) identified as women. We also note that 0.5% ($n = 104$) of agents wrote in an identity outside of the traditional gender binary and 0.4% ($n = 86$) declined to report their gender.

At the General employee level, about 60.7% of agents identified as men ($n = 10,512$), 38.3% ($n = 6,624$) identified as women, 0.6% identified outside of the traditional gender binary ($n = 97$), and 0.4% declined to report a gender ($n = 76$). However, at the Senior level, men made up about 74.4% of agents and women made up just over a quarter (25.1%; $n = 865$) of agents. The remaining 0.5% of respondents reported a gender outside of the traditional binary or declined to report a gender ($n = 17$).

Similar to our results stratified by race/ethnicity, we also see some notable trends when looking at percentages by submission year [See Figure IX.3. Percentage of Applicants who Self-Identified as Female or Male, by Year of Application Submission]. In 2019, men made up 67% of General employee registrations ($n = 637$) and 80% of Senior-level registrations ($n = 316$), compared to women who made up 32% ($n = 304$) and 20% respectively ($n = 80$). In 2023, however, men made up 58% of General employee registrations ($n = 2,292$) and 64% of

Senior-level employees ($n = 312$). This same year, women accounted for 40% of General employee registrations ($n = 1,584$) and 35% of Senior-level registrations ($n = 168$). To ensure confidentiality, we did not report totals by year for those who reported a gender outside of the traditional binary and those that declined to report a gender to preserve anonymity, as numbers by year fell below our reporting cutoff of $n = 10$.

Figure IX.3. Percentage of Applicants who Self-identified as Female or Male, by Year of Application Submission



Race/Ethnicity and Gender

We also investigated the intersectionality of race and gender within General and Senior-level positions. White men accounted for 43.9% (9,111/20,753) of all agents, accounting for 41.2% (7,123/17,309) of General employees and 57.7% (1,988/3,444) of Senior-level positions.

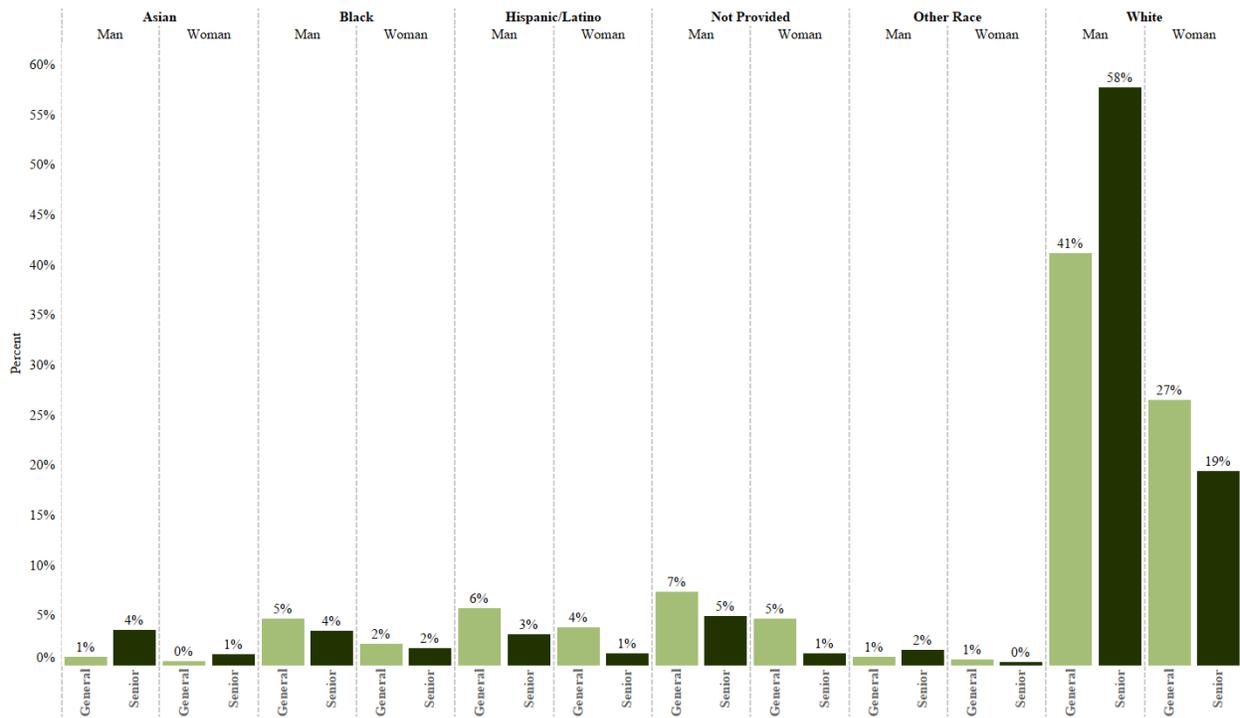
White women accounted for just over a quarter of all roles (25.4%; 5,262/20,753), amounting to 26.5% (4,593/17,309) of General employees and 19.4% (669/3,444) of Senior-level positions.

As was previously stated, agents that identified primarily as Hispanic/Latino accounted for 8.8% of the sample (1,820/20,753): 5.3% (1,100/20,753) identified as men, and 3.4% (701/20,753) as women. Hispanic/Latino men accounted for 5.7% (992/17,309) of General employees and 3.1% (108/3,444) of Senior-level positions, compared to Hispanic/Latino women who made up 3.8% (659/17,309) of General employees and 1.2% (42/3,444) of Senior-level positions.

Among the 6.6% (1,374/20,753) of all agents that identified primarily as Black/African American, 4.5% (931/20,753) identified as men and 2.1% (439/20,753) identified as women. Black men accounted for 4.7% (810/17,309) of General employees and 3.5% (121/3,444) of Senior-level positions. Black women accounted for 2.2% of General employees and 1.7% (60/3,444) of Senior-level positions.

Asian individuals made up 2.0% (405/20,753) of respondents: 1.3% (280/20,753) identified as men, and 0.6% (121/20,753) identified as women. Asian men accounted for 0.9% (157/17,309) of General employees and 3.6% (123/3,444) of Senior-level positions. Asian women accounted for 0.5% (81/17,309) of General employees and 1.2% (40/3,444) of Senior-level positions [See Figure IX.4. Role Seniority, by Race and Gender].

Figure IX.4. Role Seniority, by Race and Gender



*Note: General (Brown) and Senior-Level (Green) agent representation by Race and Gender.

Veteran Status

The Commission asks agent respondents to report whether they identify as a Veteran of one of the United States Armed Forces. A total of 514 agents, or 2.5% of our entire sample, identified as a Veteran, and 97.5% ($n = 20,239/20,753$) did not. Veterans accounted for 3.5% of Senior-level agent roles ($n = 119/3,444$), compared to 2.3% ($n = 395/17,309$) of General Employees.

Farmer Status

The Commission asks agent respondents to report whether they identify as a farmer. Across the entire sample, just 219 agents, or 1.1% of the sample, identified as farmers. Similar to Veteran status, representation of farmers was higher among Senior-level employees (2.53%; $n = 87/3,444$) than among General employees (0.8%; $n = 132/17,309$).

Summary

The adult-use cannabis industry in Massachusetts has seen remarkable growth since its 2018 inception as reflected in the growth of agent registrations. As of 2023, agent registrations were predominantly white across all positions (70%), but especially at the Senior-level (77%). The industry at large was also majority male (63%), especially at the Senior-level (74%). **However, there does appear to be increased diversity in the industry over time, with higher representation of female and BIPOC agents among new registrations in 2023 than in previous years, both in General and Senior-level positions** [See Table IX.3. Race and Ethnicity of General Employees and Senior Level Roles by Year of Application Submission].

Social Equity

The history of cannabis and its prohibition is inextricably linked to social equity in the U.S. and beyond since cannabis policies were enacted and/or implemented with racial bias (Bender, 2016; Provine, 2011; Tonry, 2010). Specifically, the War on Drug's "Law and Order" (i.e. politicization of crime) and "Crime and Punishment" (i.e. a culmination of fear of street crime that created a "morally and justified" reason for the heavy punitive response to drug crime) phenomena disproportionately affected marginalized groups who had been increasingly subject to surveillance and harsher penalties for drug crimes. In a concerning phenomenon, the War on Drugs has shown differential impacts on Black and Hispanic *non-citizen* cohorts, which may lead to detainment and deportation (Johnson, 2015; Tosh, 2021), arguably more severe impacts of the War on Drugs on disproportionately impacted persons.

The unprecedented passage of the Federal Marihuana Tax Act (1937), for instance, criminalized the cannabis plant in a move that was theorized by some legal scholars to be a tactic to discriminate against Mexican immigrants (Bonnie & Whitebread, 1970). Later, the Controlled Substances Act (CSA) of 1970 further cemented cannabis prohibition by classifying it as a substance with a high potential for abuse with no accepted medical use,

alongside heroin and hallucinogens. After the passage of the CSA, President Nixon declared drug abuse “public enemy number one,” which marked the beginning of what we now refer to as the War on Drugs in the U.S. Since the passing of the CSA, the War on Drugs proliferated across the country and caused significant harm to communities of BIPOC. More than 50 years after the CSA became law, the disproportionate impacts stemming from the unequal enforcement on BIPOC communities remains concerning, warranting policies and provisions to both rectify past harms and ensure equity in the new cannabis industry moving forward. Just six years ago in 2018, Black/African American people were arrested for cannabis possession at nearly four times the rate of their White counterparts, although national data indicate similar rates of use (ACLU, 2020). This disproportionate policing has led to the mass incarceration of Black Americans, causing enduring individual and intergenerational effects on these persons and communities (Montgomery & Allen, 2023).

American Indian and Alaska Native persons are also disproportionately excluded from participation in the regulated cannabis industry despite the historical use of cannabis and hemp in the Native culture. Native Americans are both the most impoverished racial group in the U.S. and the least likely to be business owners, partially due to the forced resettlement of many Native Americans from their ancestral lands (Carter & Rotman, 2023). Native Americans are also the most undercounted racial group due to the enduring practice of counting only individuals who select American Indian/ Alaska Native (AI/AN) as their sole identification, which disregards individuals who select AI/AN with one or more other Census categories (The Boston Foundation et al., 2019). There is no systematic surveillance of the health of Native Americans by states or the U.S., a common measure to compare metrics with other similar populations (Massachusetts Department of Public Health (MA DPH), 2006). The small percentage of American Indian/Alaskan Natives in Massachusetts, combined with metrics’ inability to isolate this cohort from other racial/ethnic cohorts, makes researching the effects of cannabis policy on this cohort in a reliable way specifically difficult. However, it is imperative that indigenous communities, such as Native Americans, are included in both drug reform and human rights, thus, social equity discussions (Burger & Kapron, 2017), despite the lack of quantitative data.

The movement to legalize cannabis at the state level is partially a response to the War on Drugs. State governments have taken initiative by responding to the will of their voters to liberalize cannabis from punitive measures and explicitly framing social equity as a policy goal. States such as Massachusetts, Illinois, New Jersey, and New York named the War on

Drugs as a primary reason for legalization. Legalization provides an opportunity to address past harms and provide future economic opportunity among disproportionately impacted persons and communities (Montgomery & Allen, 2023).

Massachusetts, which was the first state in the nation to mandate full participation in the legal adult-use cannabis industry by communities disproportionately harmed by the War on Drugs, has enacted more than ten different statutory and regulatory provisions to create equity in the new industry. As part of its mandate to address the harms from cannabis prohibition, the Commission provides certain benefits to geographic communities (“areas”) designated as disproportionately impacted (DIAs) [See Table IX.4. Massachusetts Select Equity Provisions (as of March 2023) below for comprehensive details on Massachusetts Select Equity Provisions and Appendix for priority status eligibility, including Table XI.4. Race and Ethnicity Definitions and Table XI.5. Economic Empowerment Certification Program (2018) Eligibility].

Under current regulations, applicants are eligible for the Commission’s Social Equity Program (SEP) if individuals meet at least one of the following [criteria](#):

- Income that does not exceed 400% of Area Median Income and residency in a Disproportionately Impacted Area (DIA), as defined by the Commission, for at least five of the past 10 years;
- Residency in Massachusetts for at least the past 12 months and a conviction or continuance without a finding for an offense under M.G.L. c. 94C or an equivalent conviction in Other Jurisdictions;
- Residency in Massachusetts for at least the past 12 months and proof that the SEP applicant was either married to, or the child of, an individual with a conviction or continuance without a finding for a M.G.L. c. 94C offense or an equivalent conviction in Other Jurisdictions;
- Any individual listed as an owner on the original certification of a Certified Economic Empowerment Priority Applicant who satisfies one or more the following criteria:
 - Lived for five of the preceding 10 years in a DIA, as determined by the Commission;
 - Experience in one or more previous positions where the primary population served were disproportionately impacted, or where primary responsibilities included economic education, resource provision or empowerment to disproportionately impacted individuals or communities;

- Black, African American, Hispanic or Latino descent; and
- Other significant articulable demonstration of past experience in or business practices that promote economic empowerment in a DIA.

SEP participants gain access to training and technical assistance as part of their cohort, as well as a library of course materials from previous cohorts. Additionally, SEP participants may utilize additional benefits such as access to a pre-certification application that provides applicants with preliminary application status indicating their suitability for corresponding license types, access to exclusive pro-bono/discounted wrap-around services, priority licensing review, and expedited review if SEP Participants maintain at least 10% ownership in the business. SEP and EEA businesses also have exclusive access to delivery and social consumption licenses for a minimum of three years.

Industry is also required to further equity in legal cannabis. All license applicants must submit a Positive Impact Plan and Diversity Plan prior to receiving Commission approval, which are reviewed annually at renewal to ensure progress [See Commission's 1) [Guidance on Diversity Plans](#); 2) [Guidance on Positive Impact Plans](#); and 3) Research report, [Special Report: A Baseline Review and Assessment of the Massachusetts Cannabis Industry's Required Positive Impact Plans](#)].

Massachusetts has continued to expand upon its social equity provisions since adult-use implementation in 2018. Chapter 180 of the Acts of 2022, *An Act Relative to Equity in the Cannabis Industry*, was signed into Massachusetts law on August 11, 2022, and went into effect on November 9, 2022. The regulatory goals of Chapter 180 were to level the playing field for entrants into Massachusetts' adult and medical use of marijuana industry, increase access for small businesses and those from communities that have been disproportionately harmed by cannabis prohibition, and ensure compliance with the state law. As a result, the Commission amended its existing medical and adult-use cannabis regulations to implement this new law, which significantly impacts the Massachusetts cannabis industry, particularly with respect to the agency's oversight of host community agreements (HCAs), municipal equity requirements, and agent suitability reform.

The law also created the Cannabis Social Equity Trust Fund, managed by the Executive Office of Economic Development (EOED). This fund distributes grants and loans, including no-interest loans and forgivable loans, to approved SEP Participants and approved EEAs, in consultation with the Cannabis Social Equity Advisory Board. Members of the Advisory

Board are appointed by the state Governor, Attorney General, and Treasurer, and consist of individuals with experience advocating on behalf of communities that have been disproportionately harmed by cannabis prohibition and enforcement.

Table IX.4. Massachusetts Select Equity Provisions (as of March 2023)

Provision	Legislative or Regulatory	Description
Legislative mandate to promote equitable participation	Legislative M.G.L. c. 94G, §§ 4(a)(xxviii) – 4(a) ½(iv)	Legislation requires the regulatory body for legal cannabis (Cannabis Control Commission “Commission”) to develop regulations which include, “procedures and policies to promote and encourage full participation in the regulated marijuana industry by people from communities that have previously been disproportionately harmed by marijuana prohibition and enforcement and to positively impact those communities.”
Past cannabis conviction does not exclude industry participation	Legislative M. G. L. c. 94G, §§ (4)(a)(xxviii) – (a) ½(iii)	Legislation states that “a prior conviction solely for a marijuana-related offense or for a violation...shall not disqualify an individual or otherwise affect eligibility for employment or licensure in connection with a marijuana establishment, unless the offense involved the distribution of a controlled substance, including marijuana, to a minor.”

Ownership Restrictions	Legislative M. G. L. c. 94G, §16	Legislation states “No licensee shall be granted more than three marijuana retailer licenses, three medical marijuana treatment center licenses, three marijuana product manufacturer licenses or three marijuana cultivator licenses; provided, however, that a licensee may hold three marijuana retailer licenses, three medical marijuana treatment center licenses, three marijuana product manufacturer licenses and three marijuana cultivator licenses.”
Research Requirements	Legislative M. G. L. c., 94G, § 17(a)	Legislation requires the Commission develop a research agenda which includes, “ownership and employment trends in the marijuana industry examining participation by racial, ethnic and socioeconomic subgroups, including identification of barriers to participation in the industry.”
Diversity Plan	Regulatory 935 CMR 500.101€	Regulation requires cannabis establishments to submit, as a part of licensure, a plan “to promote equity among minorities, women, Veterans, people with disabilities, and people of all gender identities and sexual orientation.” Plans must include measures to assess their success.
Positive Impact Plan	Regulatory 935 CMR 500.101(1)(a)	Regulation requires cannabis establishments to submit, as a part of licensure, a plan to positively affect people or communities which fall

		<p>into one or more the five groups:</p> <p>(1) Past or present residents of defined geographic Areas of Disproportionate Impact [ADI]; (2) Participants in Economic Empowerment Priority program;</p> <p>(3) Participants in Social Equity Program;</p> <p>(4) Massachusetts residents with past drug convictions; and</p> <p>(5) Massachusetts residents with parents or spouses with drug convictions.</p>
Disproportionately Impacted Areas (DIAs)	Regulatory See Definition Section	Regulation defines geographic areas “which has had historically high rates of arrest, conviction, and incarceration related to marijuana” in order to encourage participation and inclusion of people in these communities.
Economic Empowerment Priority Review	Regulatory See Regulatory Guidance	<p>This certification gives priority license review, fee waivers, and reductions for certificate holders (n=122 certificate holders). The deadline to apply is over (4/2/2018-4/16/2018).</p> <p>[See Appendices Table XI.5. Economic Empowerment Certification Program (2018) Eligibility for eligibility criteria]</p>
Social Equity Program	Regulatory See Regulatory Guidance	This ongoing program offers comprehensive training and technical assistance, including courses and hands-on assistance for

		<p>all levels of seniority. A total of 872 participants participated in the program's first three cohorts. Persons in the program also have fee waivers and reductions and receive expedited application review. For specific eligibility criteria see Regulatory Guidance.</p>
Expedited Application Review	Regulatory See Regulatory Guidance	<p>After priority applicants, the Commission reviews expedited applications. These include those applications from Social Equity Participants, minority-owned businesses, women-owned businesses, and veteran-owned businesses, ITLs, Outdoor Cultivators, Craft Co-Ops, and Microbusinesses, with certain restrictions.</p>
Disadvantage Business Enterprises (DBE)	Regulatory data collection	<p>The Commission collects self-reported DBE-status for all licensees and grants expedited licensing review for Supplier Diversity Office-certified minority-owned businesses, women-owned businesses, and veteran-owned businesses. See select Open Data here: https://masscannabiscontrol.com/open-data/</p>
An Act Relative to Equity in the Cannabis Industry	Legislative Session Laws, Acts 2022, Ch. 180	<p>Under state law, MEs and MTCs must execute HCAs with the municipalities in which they plan to operate.</p>

Municipal Equity Recommendations	Regulatory See Regulatory Guidance	These recommendations were created to assist municipalities in creating equitable cannabis policies to mirror the Social Equity Program established by the Commission.
Social Equity Loan Fund	Legislative M. G. L. c., 94G, § 14(a)	A fund to encourage the full participation in Massachusetts' regulated marijuana industry of entrepreneurs from communities with grants and loans, including no-interest loans and forgivable loans, to social equity program participants and economic empowerment priority applicants.
Codification of the Social Equity Program	Legislative Session Laws, Acts 2022, Ch. 180	The Commission is required to administer a social equity program/ The program offers technical assistance and training, and guidance on how to access funds available through the Cannabis Social Equity Trust Fund.

*Note: Table includes provisions related to equitable participation as of March 2023.

Application Review and DBE Status

Among license applicants that are still under review (i.e. have not commenced operations), 61.6% fall under at least one Expedited or Priority Review category. Of those that have commenced operations, 56.6% were reviewed under at least one Expedited or Priority Review category [See Table IX.5. Applications and Establishments that have Commenced Operations (Count), by Application Review Category].

Table IX.5. Applications and Establishments that have Commenced Operations (Count), by Application Review Category

Application Review Category	Applications Under Review	%	Commence Operations	%
Expedited Review - DBE Status	120	10.94%	61	9.4%
Expedited Review - License Type	46	4.19%	30	4.6%
Expedited Review - Social Equity Participant	294	26.80%	36	5.5%
Expedited Review - Two or More	43	3.92%	8	1.2%
General Applicant	432	39.38%	282	43.4%
Priority Review - Economic Empowerment Priority	101	9.21%	29	4.5%
Priority Review - MTC Priority	61	5.56%	204	31.4%
Total	1097	100.00%	650	100.00%

Among licensees that have commenced operations, 17.5% have ownership that falls into one or more DBE categories, while 82.5% have ownership that does not fall into any DBE categories [See Table IX.6. DBE Establishments that have Commenced Operations (Count), by DBE Category].

Table IX.6. DBE Establishments that have Commenced Operations (Count), by DBE Category

DBE Category	Commence Operations	%
Owner(s) not in any DBE categories	536	82.5%

Owner(s) in 2 DBE categories*	10	1.5%
Owner(s) in 3+ DBE categories	4	0.6%
LGBT-Owned	8	1.2%
Person with Disability-Owned	3	0.5%
Racial/Ethnic Minority-Owned	35	5.4%
Veteran-Owned	9	1.4%
Woman and Racial/Ethnic Minority-Owned	15	2.3%
Woman-Owned	30	4.6%
Total	650	100.0%

Unregulated Markets

In addition to supporting legacy businesses with their transition to the regulated market, another objective of legalization often linked to social equity is to decrease the scope of the unregulated market by providing adults lawful access to regulated cannabis. By providing lawful access, regulators can ensure constituents have access to safe products with little risk of legal reprimand. As part of statute, Massachusetts is responsible for ongoing monitoring of the expansion and contraction of the unregulated and regulated markets. Quantifying the scope of the unregulated market is critical for policy makers to counter potential adverse outcomes, maximize tax revenue, and safely regulate the market.

The Commission’s most recent International Cannabis Policy Study report found that patterns of unregulated and regulated markets in Massachusetts are changing. Residents reported sourcing 67% of their cannabis products legally in 2020, on average, compared to 61% of their products in 2019. Additionally, a smaller proportion of residents reported sourcing products from unregulated market dealers in 2020 (24%) compared to 2019 (32%). The percent of residents that reported purchasing their cannabis at regulated stores also increased from 2019 (41%) to 2020 (55%). These findings suggest that individuals are moving towards the regulated market.

In this study, individuals also reported different reasons for sourcing products from the unregulated market, including expense and location of licensed options being “too far.” Younger adults reported greater rates of purchasing cannabis from unregulated market dealers compared to older adults, while older adults reported greater rates of purchasing from

licensed retailers (Colby et al., 2022). This information provides further clarity for regulators towards the goal of decreasing the unregulated market. For more information about the Commission’s research on unregulated markets, see the legislative research report “[Cannabis Use Trends in Massachusetts, Findings from the International Cannabis Policy Study, 2019 and 2020.](#)”

Home Cultivation

Home cultivation allows residents to grow their own cannabis at home. Individuals may cultivate at home for various reasons, such as having more control over cannabis strains, having a low-cost or convenient source of cannabis that may be preferred over retail stores, or cultivating for the enjoyment of the growing process. Research examining individual characteristics of home cultivation among U.S. adults found that approximately 2% of past-year consumers ages 21 and older reported growing cannabis between 2010 and 2014. Notably, home cultivation was considerably higher among men, individuals living in rural areas, and individuals that consume cannabis more frequently. Higher rates were observed in the Commission’s most recent ICPS report where 9.7% of the Massachusetts resident sample ($N=1,639$) reported sourcing cannabis through home cultivation. Similar results were also observed in the Commission’s most recent ICPS report, with men being significantly more likely to report growing their own cannabis (Colby et al., 2022).

In states across the U.S. that have legalized adult-use cannabis, limits for the number of cannabis plants that residents can grow, per resident and property, vary greatly. Three studies that examined the association between state legislation and home cultivation rates found that, generally, states with more permissive cannabis laws had higher rates of respondents growing their own cannabis (Wadsworth, Cristiano, et al., 2022). Another study found home cultivation rates were also higher in adult-use states that had medical cannabis laws dating prior to 2010 (Wadsworth, Craft, et al., 2022). These findings appear to demonstrate how policy can impact home cultivation behaviors.

Massachusetts law allows residents that are ages 21 or older to cultivate cannabis at home. Individual residents may grow up to six plants maximum in their primary residence, and if more than one individual in the residence is 21 years or older, the maximum number of plants increases to a maximum of twelve plants. A Registered Qualifying Patient of the Medical Use of Marijuana Program is permitted to grow enough cannabis to yield a 60-day supply for personal, medical use, defined as enough to provide 10 ounces of usable cannabis.

To cultivate at home in Massachusetts, plants must be grown in an area that is equipped with a lock or security device and cannot be visible from a public place without the use of binoculars, aircraft, or other optical aids ([Commission Home Cultivation Webpage](#)).

X. Research and Policy Considerations

Based on analyses in preparing the Industry Report, the Commission's Research Department, in consultation and collaboration with varying Massachusetts researchers and internal departments, offer the following considerations to the Commonwealth regarding the new and growing medical and adult-use cannabis industries in Massachusetts and beyond.

Research and Data

Real world cannabis industry data refer to observational data, as opposed to data collected in a research study, which are controlled, such as randomized control trials in clinical settings. Real world data is collected by varying sources and may have differing data validity and reliability concerns that need to be addressed for its use in monitoring and/or research purposes.

External researchers identify the following limitations to similar seed-to-sale tracking systems across the U.S.: software glitches, lack of official codebooks, changes in regulations and guidance which do not align with data imputation, lack of consistency in data imputation practices or otherwise dishonest and/or neglectful reporting, and challenges discerning price and potency among all product types (Davenport, 2021; Williams et al., 2017). There are additional limitations in tracking industry participation by demographic characteristics for Massachusetts more specifically. Data for agent registrations are typically reported by owners; therefore, employee data metrics may not be valid, and certain characteristics (e.g. race/ethnicity) may be subject to greater inaccuracies. Additionally, certain demographic characteristics of underrepresented persons (e.g., persons with disabilities, LGBT+ individuals) are not captured.

As Massachusetts' Open Data platform is real-world data, with multiple entities inputting data, both seed-to-sale tracking and industry data are subject to data limitations for research, including technical, human, and compliance concerns and errors. Technical concerns and errors refer to the data repository system and functions, such as the real vs. null "0" values described in section, *VIII: Data: Testing*. Human error may occur when different persons and entities are entering plant and/or agent data into the system. There may be inconsistent use of the seed-to-sale tracking system and/or data imputation practices (e.g., coding of product type) between establishments and agents within establishments over time.

- **Consideration 1:** The Commission could create additional Guidance and FAQs for users analyzing Open Data and other data requested via a Data Use Agreement to better understand its real-world data management, application, and metric limitations for use in research. This could include codebook metrics with necessary details, including 1) dates of data collection and policies (laws, regulations, guidance) that regulators were operating under at time of data collection; and 2) detailed descriptions of how data metrics are collected and managed, which have implications for potential metric reliability and validity errors for research use. This documentation would ensure researchers understand data metric validity and reliability, and can both methodologically adjust for, as well as describe results in context of these limitations.
- **Consideration 2:** To standardize testing practices and results specific to testing, the Commission could create an outline for the methods limitations of test results regarding real test 0's vs. null 0's inherent in the design of Metrc data input, which complicate any research analysis. The Commission could collaborate with Metrc to further clarify data entry processes for Licensees. Additionally, moisture content could be added to the tracking system to facilitate analyzing the reliability of testing metrics in the platform [See Testing Considerations below for other related testing considerations].
- **Consideration 3:** Continued study of the hemp-derived cannabinoid market in Massachusetts and nationally may assist in better informing how Massachusetts can ensure public health and safety in the evolving hemp and cannabis markets, as well as understanding hemp's impacts on cannabis markets. The Commission could work with Cannabis Regulator Association (CANNRA) states, MDAR, and other Massachusetts state agencies and stakeholders to further understand the scope of hemp-derived cannabinoid use and make evidence-based changes as necessary, such as increased public awareness or research.
- **Consideration 4:** Massachusetts has multiple statutory and regulatory provisions to increase equity in the new cannabis industry. To ensure effectiveness, it is imperative that regulators and researchers alike understand the varied impacts of these individual and collective provisions, and any potential barriers to their success. Increasing data collection on equity provisions would allow for an

expanded understanding of current equity provision effectiveness and potential improvements, including working with external stakeholders to reduce barriers outside the jurisdiction of the Commission and Commonwealth. For example, utilizing data collection capacity to follow Social Equity Program Agents through their careers in the cannabis industry or tracking changes in ownership demographics would allow regulators to understand how the Social Equity Program is helping individual participants, and to enact proactive and timely regulatory or program adjustments if deemed necessary for program effectiveness.

- **Consideration 5:** It is important to understand the scope of the unregulated cannabis market in the state to help transition cannabis consumers to the regulated medical and adult-use markets. Commission researchers could work with CANNRA colleagues across the nation and worldwide to understand trends occurring across other regulated states and jurisdictions, as well as Massachusetts' public safety entities, to ensure we correctly identify data needs and opportunities to understand the unregulated market(s). Unregulated markets are harder to study due to the inherent lack of standardized data collection mechanisms available in the regulated markets. Researchers could triangulate multiple data sources, including seed-to-sale tracking [regulated industry trends]; survey metrics, including questions about cannabis sourcing, such as the International Cannabis Policy Study (ICPS); and public safety data, including the National Incident Based Reporting System (NIBRS) to assess cannabis-related criminal justice system interactions, which could provide additional information on some of the unregulated market activity and trends before and after legalization.
- **Consideration 6:** Patient equity, access, and safety are collective concerns for all states moving from a solely medical market to a medical and adult-use market. Thus far, Massachusetts has not experienced steep patient declines after the implementation of the adult-use cannabis market; however, continued monitoring and understanding of patients' use, accessibility, sustainability, and protections merit ongoing monitoring and evaluation [See the Commission's article, Medical Program Sustainability in the Era of Recreational Cannabis]. The Commission continues to collect macro-level data on patient demographics and conditions; however, this could be supplemented by patient survey data to better understand the distinct and individualized needs and uses of the Medical Use of Marijuana

Program. Additional quantitative and qualitative data collection on patients and the medical program would allow the Commission to best serve patients and ensure the sustainability of the medical program in an evolving cannabis policy landscape.

- **Consideration 7:** The Commission is tasked with implementing policies intended to help rectify past harms of the historic disproportionate enforcement of drug policy on persons of color (“War on Drugs”). As of September 2024, Massachusetts has enacted varying social equity provisions, including legislative and regulatory provisions. Comprehensively, these provisions are intended to promote diverse participation and ownership in the new industry and study the continued disproportionate effects of cannabis policy. To most effectively execute this critical mission, it is essential to have agency and state-wide data collection mechanisms that support the ability to assess differential trends among impacted cohorts. It is critical to ensure data collection mechanisms and metrics align with the most recent federal recommendations [See Federal Interagency Technical Working Group on Race and Ethnicity Standards and Revisions to Federal Standards for Collecting and Reporting Data on Race and Ethnicity].

Testing

Massachusetts has created a complex testing infrastructure to ensure policies and practices are in alignment with current and emerging best practices of similar commodities and cannabis testing across the U.S. This work is ongoing, often needing to adapt to varying legal and industry trend changes, as well as innovations in the underlying science. Sans federal guidance and oversight, considerations listed below are intended for the Massachusetts industry but may be useful for cannabis regulators at large.

Along with other key states, Massachusetts can continue to also be a leader in cannabis industry testing as industry practices and research continue to evolve. At this point in time, due to a nationwide focus on testing and understanding that these issues continue to evolve, information outlined below may enable better analysis of trends and practices to inform evidence-based policy discussions in the future.

- **Consideration 1:** In a constantly evolving policy and scientific landscape, and without federal oversight, it is critical that states work collaboratively with

regulators, scientists, experts, industry, and other key stakeholders to guide evidence-based practices and policies as science and best practices continue to evolve.

- **Consideration 2:** Regulators could enhance and improve industry monitoring of seed-to-sale tracking testing data to monitor any abnormalities in the data, ensuring data validity and reliability. These processes, ideally conducted by Data Analysts, either internal or external, could be added to the regulatory processes of IT and Enforcement teams. This would require additional staffing and/or contract work, but may aid to prevent any potential adverse public health, clinical, or safety effects for the regulated industry as they arise. Additionally, consideration of external researchers to analyze or validate analysis may facilitate greater public confidence in the objectivity of data analysis.
- **Consideration 3:** Regulators should monitor research related to TYM and other contaminant testing standards for adult-use and medical markets. The medical use market may merit stricter standards than the adult use market – for example, patients who are immunocompromised may be more sensitive to contaminants. As the consumers in the adult-use vs. medical-use markets may have differential risks in cannabis consumption, medical market products may merit different thresholds. As the cannabis industry grows across the U.S. and science better understands outcomes, it is important for the industry and regulators to better understand testing trends and to make necessary changes as needed in the future. Additionally, differences in indoor and outdoor cultivation may merit ongoing assessments to fine-tune standards to ensure product safety.
- **Consideration 4:** After data collection and monitoring, and as the science advances, regulators could work with scientists, experts, and industry to regularly revisit the varying mandated testing components, such as individual components vs. whole categories (i.e., microbial contaminants, mycotoxins, pesticides, and other contaminants) to ensure both industry cost effectiveness and public health and safety. For example, not all yeast or mold may be detrimental to health, but science is still developing in this area. Evidence based policies and practices should continue to follow the science. Additionally, testing requirements for the medical and adult-use markets may need to be evaluated separately to ensure extra protections for patients. Regulators could incorporate additional benchmarks of

good manufacturing practices as they continue to develop nationally, which may help cultivators produce safer products with the science as it continues to evolve.

- **Consideration 5:** To provide additional consumer protection, as well as fidelity of industry compliance, the Commission may offer consumer education and off-the-shelf testing practices or a state-run standard testing laboratory.
- **Consideration 6:** Sans federal testing mandates, standards, and practices, real-world (“applied”) industry data are constructed for industry tracking (but not research evaluation and monitoring). Currently, there are challenges and limitations for researchers with the manner in which ITLs report and Metrc retains information (such as the issue of default or “null” 0s) which could be streamlined for research purposes. Potency appears to be gradually increasing across legalized states nationally, which is important to monitor for licensee compliance and public health/safety. Researchers would benefit from data that can be analyzed in a more straightforward manner. Intermixing real and “null” results hampers the ability of regulators and researchers across the country to continue improving policy.

XI. Appendices

Table XI.1. Explanation of General Acronyms

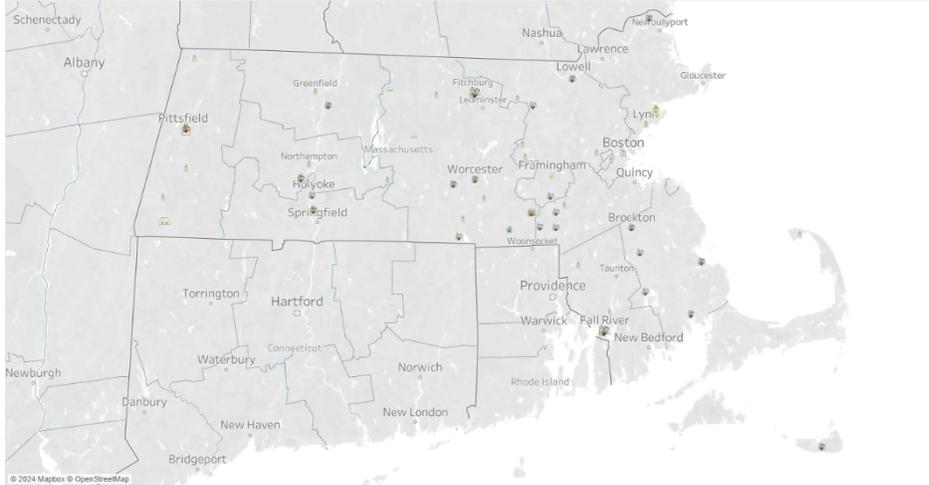
Acronym	Meaning
ACS	American Community Survey
AHP	American Herbal Pharmacopoeia
BIPOC	Black, Indigenous, and People of Color
CANNRA	Cannabis Regulators Association
CBD	Cannabidiol
CBD-A	Cannabidiolic Acid
CBN	Cannabinol
CCC	Cannabis Control Commission
CDC	Center for Disease Control
CFU	Colony Forming Unit
CSA	Controlled Substances Act
DBE	Disadvantaged Business Enterprise
DEA	U.S. Drug Enforcement Agency
DIA	Disproportionately Impacted Areas
DIO	Diversity in Ownership
DPH	Department of Public Health
ECS	Endocannabinoid System
EEA	Economic Empowerment Applicant
EOED	Executive Office of Economic Development
EPA	Environmental Protection Agency
EVALI	Electronic Vaping Associated Lung Injury
FDA	U.S. Food and Drug Administration
GHB	Gamma Hydroxybutyric Acid
HCA	Host Community Agreement
HHS	Department of Health and Human Services
ICPS	International Cannabis Policy Study
ITL	Independent Testing Lab
LGBT+	Lesbian, Gay, Bisexual, Transgender
M.G.L.	Massachusetts General Law
MA	Massachusetts

MDAR	MA Department of Agricultural Resources
ME	Marijuana Establishment
MBE	Minority Business Enterprise
MME	Medical Marijuana Establishment
MTC	Medical Marijuana Treatment Center
NIBRS	National Incident Based Reporting System
NSDUH	National Survey on Drug Use and Health
RFI	Request for Information
RMD	Registered Marijuana Dispensaries
SEP	Social Equity Program
SDO	Supplier Diversity Office
THC	Tetrahydrocannabinol
D8-THC	Delta 8-Tetrahydrocannabinol
D9-THC	Delta 9-Tetrahydrocannabinol
THC-A	Tetrahydrocannabinolic Acid
TYM	Total Yeast and Mold
U.S.	United States
USDA	U.S. Department of Agriculture
USP	United States Pharmacopeia
VEA	Vitamin E Acetate

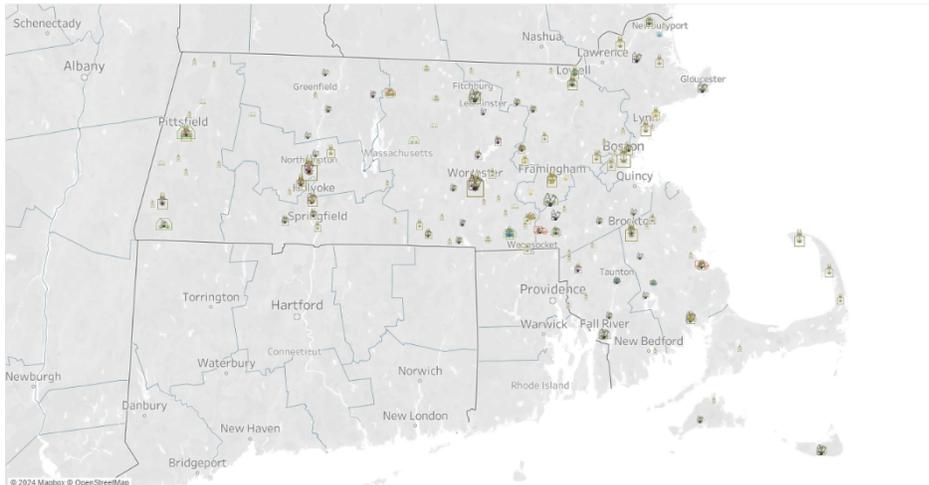
Data: Adult-Use Marijuana Establishments

Figure XI.1-3. Adult-Use Licenses: Distribution of Licenses Across the Commonwealth over time

**All Marijuana Establishments
4/30/2020**



**All Marijuana Establishments
4/30/2022**



All Marijuana Establishments

4/30/2024

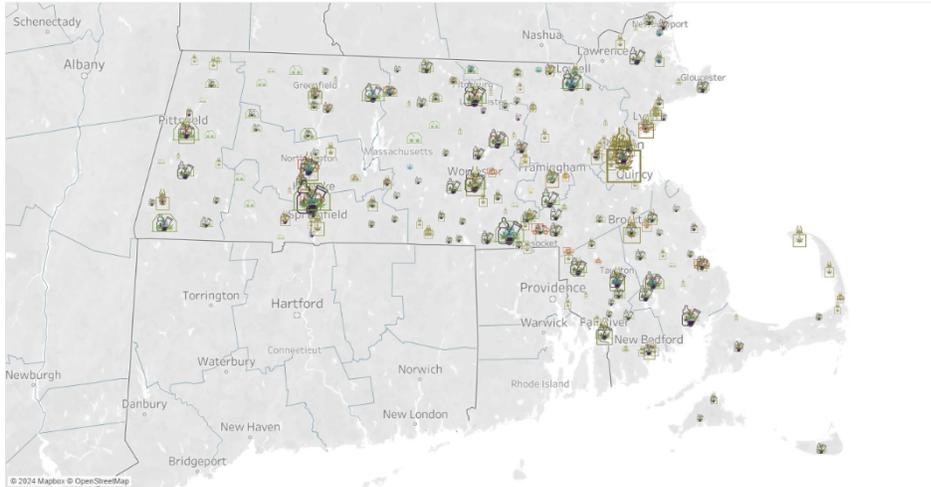


Figure XI.4. License Types

License Type (group)	License Type	
Craft Marijuana Cooperative, Microbusiness and Microbusiness Delivery	Craft Marijuana Cooperative	
	Marijuana Microbusiness	
	Microbusiness Delivery	
Independent Testing Laboratory	Independent Testing Laboratory	
Marijuana Cultivator	Marijuana Cultivator	
Marijuana Product Manufacturer	Marijuana Product Manufacturer	
Marijuana Research Facility	Marijuana Research Facility	
Marijuana Retailer	Marijuana Retailer	
Transportation	Marijuana Courier	
	Marijuana Courier Pre-Certification	
	Marijuana Delivery Operator	
	Marijuana Delivery Operator Pre-Certification	
	Marijuana Transporter with Other Existing ME License	
	Third Party Marijuana Transporter	

Table XI.2. All Applications (Count), Under Review or Operating

License Type	Under Review		Commence Ops		Total
	Count	%	Count	%	Count
Craft Marijuana Cooperative	6	100%	0	0%	6
Independent Testing Laboratory	5	24%	16	76%	21
Marijuana Courier	25	71%	10	29%	35
Marijuana Courier Pre-Certification	114	100%	-	-	114
Marijuana Cultivator	295	70%	127	30%	422
Marijuana Delivery Operator	33	75%	11	25%	44
Marijuana Delivery Operator Pre-Certification	117	100%	-	-	117
Marijuana Microbusiness	29	71%	12	29%	41
Marijuana Product Manufacturer	227	67%	110	33%	337
Marijuana Research Facility	7	100%	0	0%	7
Marijuana Retailer	210	37%	356	63%	566
Marijuana Transporter with Other Existing ME License	11	79%	3	21%	14
Medical Marijuana Treatment Center	3	100%	0	0%	3
Microbusiness Delivery	6	100%	-	-	6
Third Party Marijuana Transporter	9	64%	5	36%	14
Total	1,097	63%	650	37%	1,747

*Note: There are no applications for Marijuana Courier Pre-Certification and Marijuana Delivery Operator Pre-Certification that have commenced operations, because these are part of the application processes for Marijuana Courier and Marijuana Delivery Operator, respectively. Similarly, there are no applications for Microbusiness Delivery that have commenced operations, because Microbusiness Delivery is an Endorsement, rather than a license.

Table XI.3. Licensees (Count), by License Type and Year of Commencing Operations

License Type	Year of Commencing Operations							Total
	2018	2019	2020	2021	2022	2023	2024	
Independent Testing Laboratory	2		1	5	3	5		16
Marijuana Courier				6	3	1		10
Marijuana Cultivator	2	20	21	26	27	19	12	127
Marijuana Delivery Operator					4	6	1	11
Marijuana Microbusiness		1	1	3	3	3	1	12
Marijuana Product Manufacturer	2	18	18	22	25	19	6	110
Marijuana Retailer	5	27	63	97	70	73	21	356
Marijuana Transporter with Other Existing ME License		2			1			3
Third Party Marijuana Transporter			2	1	1	1		5
Total	11	68	106	160	137	127	41	650

Data: Agents, Access, and Equity—Priority Status Data

Table XI.4. Race and Ethnicity Definitions

Description [as recorded in Massachusetts seed-to-sale tracking system]
White (German, Irish, English, Italian, Polish, French)
Asian (Chinese, Filipino, Asian Indian, Vietnamese, Korean, Japanese)
American Indian or Alaska Native
Black or African American (of African Descent, African American, Nigerian, Jamaican, Ethiopian, Haitian, Somali)
Declined to Answer
Hispanic, Latino, or Spanish (Mexicano or Mexican American, Puerto Rican, Cuban, Salvadoran, Dominican, Colombian)
Middle Eastern or North African (Lebanese, Iranian, Egyptian, Syrian, Moroccan, Algerian)
Native Hawaiian or Other Pacific Islander (Native Hawaiian, Samoan, Chamorro, Tongan, Fijian, Marshallese)
Some Other Race or Ethnicity

Table XI.5. Economic Empowerment Certification Program (2018) Eligibility: Applicants must have met 3:5 criteria

Majority of ownership belongs to people who have lived in areas of disproportionate impact* for five of the last ten years
Majority of ownership has held one or more previous positions where the primary population served were disproportionately impacted, or where primary responsibilities included economic education, resource provision or empowerment to disproportionately impacted individuals or communities
At least 51% of current employees/sub-contractors reside in areas of disproportionate impact and will increase to 75% by first day of business
At least 51% of employees or sub-contractors have a drug-related CORI, but are otherwise legally employable in a cannabis-related enterprise
A majority of the ownership is made up of individuals from Black, African American, Hispanic, or Latino descent
Owners can demonstrate significant past experience in or business practices that promote economic empowerment in areas of disproportionate impact

XII. References

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