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June 29, 2018

Steven T. James
House Clerk
State House Room 145
Boston, MA 02133

William F. Welch
Senate Clerk
State House Room 335
Boston, MA 02133

Dear Mr. Clerk,

Pursuant to Section 18 of Chapter 351 of the Acts of 2016, please find enclosed a report from the Department of Public Health entitled "Marijuana Baseline Health Study Report of Findings."

Sincerely,

Monica Bharel, MD, MPH
Commissioner
Department of Public Health

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Charles D. Baker
Governor

Karyn Polito
Lieutenant Governor

Marylou Sudders
Secretary

Monica Bharel, MD, MPH
Commissioner

Marijuana Baseline Health Study Report of Findings

June 29, 2018

Massachusetts Department of Public Health

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Legislative Mandate

The following report is hereby issued pursuant to Section 18 of Chapter 351 of the Acts of 2016, which reads as follows:

> Section 18. Within 60 days from the effective date of this act, the department of public health, in consultation with the executive office of health and human services, the executive office for administration and finance and the executive office of public safety and security, shall enter into an agreement with a research entity to conduct a comprehensive baseline study of marijuana use in the commonwealth which shall include, but not be limited to, a survey of: (i) patterns of use, methods of consumption and general perceptions of marijuana; (ii) incidents of impaired driving and hospitalization related to marijuana use; and (iii) economic and fiscal impacts for state and local governments, which shall include the impact of legalization on the production and distribution of marijuana in the illicit market as well as costs and benefits to state and local revenue. The department shall submit a report of its findings to the chairs of the senate and house committees on ways and means and the senate and house chairs of the joint committee on public health not later than July 1, 2018.

Executive Summary

Purpose

The purpose of this report is to provide a summary report of findings from the Massachusetts Department of Public Health (DPH) Marijuana Baseline Health Study (MBHS) describing the (i) Patterns of use, methods of consumption, and general perceptions of marijuana; (ii) Incidents of impaired driving and hospitalization related to marijuana use; and (ii) Economic and fiscal impacts for state and local governments.

Findings

(i) Patterns of Use and Perceptions of Marijuana

- A survey of adults in Massachusetts suggests that approximately 21% of adults have used marijuana in the past 30 days. The proportion of marijuana use was highest among those 18-25 years old. Smoking is the most common method of marijuana consumption, although more than 40% of marijuana users report using multiple methods of use. More than half of adults perceive marijuana to have slight or no risks, and use marijuana for non-medical purposes.

- A survey of patients who use marijuana products for therapeutic use suggests these individuals use marijuana treatments for approximately 24 days a month, with the majority or respondents using a marijuana product for at least 21 out of the past 30 days. On average, respondents spend at least $246.00 on marijuana each month, and use at least 3 different modes of use. The most common method of marijuana administration is smoking

(combusting) dried flower (65%), followed by vaporizing marijuana concentrate (62%) and eating marijuana products (51%).

(ii) Incidents of Impaired Driving and Hospitalization

- Tools to reliably ascertain levels of marijuana exposure and impairment in the field do not currently exist. Marijuana has cognitive and behavior effects in the areas of automative behavior (i.e., well-learned skills), and executive function impacts (i.e., how the user interacts with traffic). These effects have not been reliably linked to a level of marijuana or THC in the body.

- In a survey of Massachusetts residents, among respondents that use marijuana, the prevalence of self-reported driving under the influence is 34.3%. Overall, 7.2% of the adult population drove under the influence of marijuana in the past 30 days, and 11.3% of adults rode with a marijuana-using driver in the past 30 days. This is similar to estimates from a survey of medical marijuana patients that found approximately 10% of respondents drove under the influence in the past 30 days.

- Retrospective evaluations of fatal crash data suggest that drivers who died in a fatal crash are much more likely to have had their blood tested for marijuana, than drivers who survived a crash in which there was at least one fatality.

- Marijuana-related treatment is a small portion of the overall volume of substance use disorder treatment episodes. In a statewide-survey of Massachusetts, no respondents reported marijuana-related use of emergency room or urgent care facilities.

- The number of marijuana-related calls to the Regional Poison Control Center in Massachusetts has been increasing over time. The calls include incidents of unintentional exposures among children, with the majority of calls related to 10-19 year old individuals, and/or exposure to dried marijuana flower. The proportion of calls increased after medical marijuana was available in the Commonwealth.

(iii) Economic and Fiscal Impacts for State and Local Governments

- Economic projections suggest that marijuana will increase Massachusetts state revenue by about $215.8 million in the first two years of retail sales. The increase will largely come from sales and excise taxes collected on retail purchases. Based on experiences from states with existing legalized adult use, sales tax revenue will be higher in the second year ($154.2 million), as compared to the first year ($61.6 million).

- Economic projections of the impacts to local government, suggest that local tax revenue over the first two years of retail sale are projected to be highest in the most densely populated regions (ranging from $233,498 to $2,875,048), with considerable fluctuation in two-year revenue projections among high-density suburban cities and towns (ranging from $68,139 to $991,873, over the two year period).

Report Body

Introduction

A legislative mandate required the Massachusetts Department of Public Health (DPH) to conduct a baseline study to investigate three topics: (1) Patterns of use, methods of consumption, and general perceptions of marijuana; (2) Incidents of impaired driving and hospitalization related to marijuana use; and (3) Economic and fiscal impacts for state and local governments (Chapter 351 of the acts of 2016). This study, referred to as the Marijuana Baseline Health Study (MBHS), was conducted by DPH, under the leadership of the DPH Commissioner, in consultation with the Executive Office of Health and Human Services, the Executive Office for Administration and Finance, and the Executive Office of Public Safety and Security. Pursuant to the legislative mandate, DPH entered into an agreement with the following research entities to assist with the execution the study: UMass[1], Mathematica Policy Research Inc., and JSI Research and Training, Inc. This document serves as a summary of report findings.

Topic 1: Patterns of Use and Perceptions of Marijuana

a. Retrospective Evaluation

A retrospective analysis of previous surveys of "marijuana use" was conducted by comparing national and state-specific information from three states which have legalized marijuana, compared to three states which have not. This evaluation was conducted to identify indicators which may be sensitive to factors associated with legalization of marijuana, thus providing a valuable reference to monitor trends in use and perceptions of marijuana as the legalization of marijuana progresses. This retrospective analysis suggests that thirteen different indicators from national surveys with information available at the state level appear to be responsive to factors associated with the legalization of marijuana and sensitive to changes over time. These indicators include evaluating if minors have "ever used marijuana," and if they "believe occasional use poses no risk of harm." The evaluation also suggests that monitoring similar indicators in adults is valuable, as well as monitoring indicators of "perceptions of great risk from smoking marijuana once a month" and "any use in the past year."

b. Statewide Survey

A cross-sectional population-based survey of adults was conducted to assess past 30-day use of marijuana, alcohol, and other substances. For each of these three substance types, the survey collected information on frequency of use, spending on the substance, driving under the influence, riding as a passenger with a driver under the influence, and use of emergency room or urgent care services. The mail and web-based survey was designed to be representative of adults in Massachusetts, age 18 years or older. Participants were chosen randomly using address-based

[1] UMass refers to the combined efforts of the Applied Research & Program Evaluation Group at the UMass Donahue Institute, and the Department of Health Promotion and Policy at the UMass Amherst School of Public Health and Health Sciences.

sampling from a list of Massachusetts residential households obtained through a sampling vendor. The sample was stratified by 6 regions (Boston, Central, Metrowest, Northwest, Southeast, and Western). A simple random sample of 15,000 addresses were selected to participate with an equal number of households (n = 2,500) selected from each region.

Once duplicates were removed from the study results, there were 3,022 individuals that responded to the survey (21.8% response rate). The respondent data was weighted to allow estimates to be representative of the entire Massachusetts population. These weighted results suggest that 21% of adults in Massachusetts have used marijuana in the past 30 days; 26% of men and 17.0% of women. The proportion of marijuana use was highest among those 18-20 years of age and 21-25 years (54.4% and 49.1%, respectively), as compared to older age groups. Eighteen percent of adults aged 26 or older had used marijuana in the past 30 days. By region, residents in the Western area of the state report the highest prevalence of past 30-day marijuana use (~30%). Among marijuana users living in Massachusetts, most are White, 70.8%, and many fewer are Hispanic, 12.0%, Black, 7.1%, other, 6.9%, or Asian, 3.2%. In statistical analysis of the data (which accounted for the effect of other factors), race/ethnicity was not associated with marijuana use, suggesting that the likelihood of using marijuana is similar for each group (compared to Whites). Fifty-three percent of adults perceive marijuana to have slight or no risks. The patterns of marijuana consumption indicate that smoking is most common, although 43% of marijuana users report using more than just one method. More than half of all adult marijuana users (56.0%) report using marijuana only for adult non-medical purposes. Data suggest that men are more likely than women to report past 30-day use, and adults 18-20 years old are more likely to have used marijuana, compared to adults older than 26 years old. Marijuana use is positively associated with past 30-day alcohol use. Population groups such as men, White, non-Hispanic individuals and individuals age 18-20 years had the highest prevalence of marijuana use, when compared to other groups.

c. Survey of Medical Use of Marijuana Patients

An online survey of the patterns of use and perceptions of marijuana was sent to patients actively using medical marijuana. The survey remained open for approximately 5 weeks, with a stated goal of characterizing how regulated legal retail marijuana is consumed in Massachusetts. The survey included 81 questions focused on collecting information on demographics, product use, methods of use, perceptions of medical use, driving behavior, alcohol consumption, non-medical use of prescription drugs and other substances, and combined substance use.

A total of 6,934 participants completed the entire survey, for a response rate of 16%. There were no notable differences between respondent gender, age, or county of residence as compared to the eligible population (i.e., all patients). On average, respondents indicated marijuana use for 23.5 out of the past 30 days, with over 60% reporting marijuana use at least 21 out of the past 30 days. However, 8% of respondents reported no use of marijuana or marijuana products in the past 30 days. Over 65% of respondents reported using marijuana or marijuana products for medical purposes for at least 1 year, with approximately 1 in 5 of respondents using marijuana or marijuana products for medical purposes for at least 3 years. On average, respondents reported spending $246 on marijuana products in the past 30 days, with a significantly larger amount spent among respondents under 50 years old and among respondents with an educational attainment less than a

Bachelor's degree. On average, participants reported using approximately 3 different modes of use in the past 30 days. Approximately 16% of respondents who indicated marijuana use in the past 30 days reported using only 1 method of administration, while over 30% reported using 4 or more methods. The most common method of marijuana administration was smoking dried flower (65%), followed by vaporized marijuana concentrate (62%) and edible marijuana products (51%). The amount of product used varied by gender, age group, and educational attainment. A significantly larger proportion of males compared to females reported using vaporized dried flower or a concentrated preparation of THC referred to as "dabbing", while a larger proportion of females compared to males reported using sublingual or orally administered uptake products and applying topical cannabis products to the skin. A significantly larger proportion of respondents 50 years old or younger reported smoking (combusting) dried flower cigarettes (or "joints"), vaporizing dried flower, vaporizing marijuana concentrate, dabbing, or consuming edible marijuana products. A significantly larger proportion of respondents with an educational attainment less than a Bachelor's degree reported smoking dried flower and dabbing compared to respondents with a Bachelor's degree or higher.

All respondents were asked questions related to their perceptions of the medical use of marijuana. Over 65% of respondents reported that they believed marijuana products have been "very effective" in treating their medical condition(s), while an additional 26% believed use of marijuana to be "effective." Almost 90% of respondents reported that they had "somewhat high" or "very high" confidence that they were receiving safe, uncontaminated products when purchasing marijuana or marijuana products at a registered medical marijuana dispensary. All respondents were asked questions related to positive and negative outcomes/consequences of their marijuana use. Overall, respondents reported high rates of positive outcomes/consequences of marijuana use, and little obvious harm. Among all respondents, 78% reported positive changes in their mood or mental health, and 67% reported improved physical health. In addition, 83% of respondents reported no negative outcomes/consequences related to their marijuana use. Approximately 10% of respondents reported driving or operating a car or other motor vehicle while under the influence of marijuana in the past 30 days.

Topic 2: Incidents of Impaired Driving and Hospitalization

a. *Measuring Marijuana and Driving Impairment*

Marijuana intoxication can impair psychomotor and cognitive functions related to driving and increase the risk of involvement in a motor vehicle crash. A literature review was conducted to examine the state of the science on quantifying marijuana and impairment leading to the inability to operate a motor vehicle. Various point-of-collection (POC) devices/kits were compared to standard analytical chemistry methods (e.g., gas chromatography mass spectrometry, or liquid chromatography- tandem mass spectrometry) to determine concentrations of Δ9-tetrahydrocannabinol (THC), the primary psychoactive compound in marijuana. While some of the POC devices showed a screening-level accuracy that meets or exceeds recommended standards, they are limited in their ability to serve as a diagnostic tool to indicate driving impairment. The review of studies assessing cognitive and behavioral impacts of marijuana that are relevant to driving indicate that marijuana has cognitive and behavior effects in the areas of automative behavior (i.e. well-learned skills), especially for occasional users, and there also are

likely executive function impacts (i.e. how the user interacts with traffic) for some users. Additional research is needed to establish baseline levels of cannabinoids in blood, urine, and saliva, and the relationship between these levels and marijuana use. Additional data are also needed to characterize the variability in cannabinoid levels across product types and modes of consumption.

a. Baseline Assessment of Medical Use of Marijuana Patients

A baseline assessment of medical marijuana patients is underway to characterize levels of marijuana and marijuana metabolites in individuals who regularly consume regulated retail marijuana products. These data are needed to establish levels of marijuana metabolites or breakdown products in the bodies' of frequent marijuana users. Participants in this study were recruited from the MBHS Medical Use of Marijuana Patient Survey (described previously), and invited to attend a single, 75-minute appointment at various locations across the state. Prior to the appointment, the individuals are mailed a diary to record their daily use of marijuana products and driving activities over the seven days prior to the appointment. Once at the appointment, study staff collects the participant's diary, execute a questionnaire, conduct a physical and cognitive evaluation (to ensure that the participant is not impaired at the time of sample collection); and collect biological specimens (i.e., blood and urine) for quantitative analyses of cannabinoid levels in the Toxicology Unit of the Forensic Chemistry Section at the Massachusetts State Police Crime Laboratory (MSPCL). Individual participants were not identified to the MSPCL, but were offered the opportunity to receive an interpreted analysis of the toxicology results from study staff within 9 months of their sample collection appointment. Specimen collection began in mid-May and is on-going, with a goal of collecting samples from 250 individuals from across the Commonwealth.

b. Marijuana-Involved Motor Vehicle Crashes in Massachusetts

Baseline prevalence of self-reported DUI-marijuana and riding with a driver under the influence of marijuana (RUI-marijuana) was characterized to identify demographic risk factors associated with these behaviors. Retrospective trends and patterns of marijuana-involved motor vehicle crashes in Massachusetts were investigated between 2006 and 2016, using (1) DUI and RUI data collected as part of a statewide baseline survey of Massachusetts adults age 18 years and older; (2) Prevalence of marijuana, alcohol and drug-involved fatal crashes in Massachusetts from 2006-2016; and (3) Marijuana-involved non-fatal crashes in Massachusetts. The baseline data in Massachusetts suggests that approximately 7% of adults drove under the influence of marijuana in the past 30 days and about 12% of adults rode with a driver who was under the influence of marijuana. Nearly 35% of adults who reported marijuana use also reported DUI-marijuana, and a similar proportion reported RUI-marijuana. Retrospective evaluation of fatal crash data suggest that over the 11-year study period of 2006-2016, there were an average of 351 crashes per year in which someone died and an average of 373 traffic fatalities per year. Approximately 73% of the drivers who died in a crash were administered a post-mortem blood test. Of the deceased, blood-tested drivers, there was an increasing trend for the proportion or drivers testing positive for any cannabinoid post-mortem. In contrast, alcohol-involved crashes in Massachusetts have steadily decreased in frequency since 2006. In an examination of non-fatal crash data, an increasing number and proportion of crash reports describe marijuana. These reports preclude the accurate

characterization of marijuana-involved, non-fatal crashes as the crash reports do not systematically include reporting of drug testing.

c. Marijuana-Related Health System Contacts in Massachusetts

The use of health care systems by frequent and occasional marijuana users was evaluated to determine the number and prevalence of (1) substance use treatment admissions for a primary diagnosis of cannabis use disorder; (2) emergency room and urgent care services due to marijuana, and (3) marijuana-related calls received by the regional poison control center (PCC). This phase of the study sought to provide a summary of valuable health system-related indicators from before retail sales of adult use marijuana. For this phase, three data sources were utilized for analyses. First, Massachusetts-specific data were extracted from a national substance use database to compile the number of marijuana-related treatments over 2004-2014. Second, baseline data from the statewide survey on emergency or urgent care related to marijuana use, alcohol use, and other substance use were evaluated. Finally, data from the Massachusetts and Rhode Island Regional Poison Control Center (PCC) were evaluated to characterize marijuana-related calls (for all exposure reasons) by age and year, trends in specific marijuana product type as the source of exposure (e.g. dried plant, edible preparation, etc.).

These evaluations suggest that marijuana-related treatment is a small portion of the overall volume of substance use disorder treatment episodes, with an estimated prevalence of 45 admissions per 100,000 individuals. Of the 436 individuals who reported using marijuana in the past 30 days on the statewide-survey, no respondents reported marijuana-related use of emergency room or urgent care services in the prior year. Data from the PCC suggest that the number and proportion of marijuana-related calls has been increasing over time for all age groups. For example, during the 10-year study period (2007-2016) there were 641 calls to the PCC that involved marijuana exposure, equal to a prevalence of 9.4 calls per a 100,000 population. The evaluated calls include incidents of unintentional exposures among children age 0-9 years old (n = 27, 4.21%). The greatest number of calls were related to 10-19 year old individuals (n = 257, or 40.09%). The proportion of calls due to marijuana exposure in individual ages 0-5, 6-9, and 10-20 years old showed a statistically significant increase after medical marijuana was enacted in the Commonwealth. In all age groups, it was exposure to dried cannabis plant that resulted in the greatest number of calls to poison control, followed by edible preparations.

Topic 3: Economic and Fiscal Impacts for State and Local Governments

To evaluate the potential economic impacts on state and local government, a model was constructed to estimate the fiscal impacts during the first two years of retail sales. The model included three parts: (1) a main model, which included measures that were assumed to be major drivers of state economic impacts for which there is strong evidence to inform estimates (e.g., sales tax revenue, regulatory oversight costs and revenue, and reductions in marijuana-related law enforcement activities); (2) a supplemental model, which evaluated secondary impacts on public health, public safety, and income tax revenue for which the strength of the evidence is less definitive; and (3) a local model, which estimates local tax revenue for each city or town in Massachusetts (assuming the maximum local tax rate of 3%).

This approach suggests that marijuana will increase Massachusetts state revenue by about $215.8 million in the first two years of retail sales. The increase will largely come from sales and excise taxes collected on retail purchases. Based on experience from states with existing legalized adult use, sales tax revenue will be higher in the second year ($154.2 million), as compared to the first year ($61.6 million). When measures calculated with less certainty are included in the model (because of either a lack of data or uncertain timing), the state revenue may increase by an additional $65.3 million. Because the model includes multiple measures, the overall estimate compounds uncertainty from each of the measures. To address this, low and high ranges have been calculated. For example, the total fiscal contribution could range from $95.7 to $405.9 million, with two major assumptions heavily influencing the estimates. The first assumption involves the number of expected marijuana users in Massachusetts. While the model uses previous population surveys that show a prevalence of use ranging from 8.6% to 12.1%, data collected in Massachusetts suggest that it may be as high as 20.1%. When this Massachusetts-based estimate is used, revenue projections increased by 38% (from $215.8 million to $298.8 million). Another source of uncertainty is the changes that arise in a state when moving a regulated medical marijuana marketplace to a combined medical and adult-use marketplace, versus changes in a state going from no sales to adult-use retail sales.

The model-based approach of estimating fiscal impacts to local government, projects that local tax revenue over the first two years of retail sale are projected to be highest in the most densely populated regions (ranging from $233,498 to $2,875,048), with considerable fluctuation in the two-year revenue projections in high-density suburban cities and towns (ranging from $68,139 to $991,873, over the two year period). These local analyses assume that approximately 65% of marijuana users would shift from purchasing their marijuana in the illicit marketplace to purchasing from a dispensary. In general, the estimated median local tax revenue over the first two years of retail sale ranges from $72,835 in suburban communities with a low population density, to $582,899 in urban communities with a high population density. Because these model estimates rely on the location and availability of dispensaries, each community-level estimate is dependent upon the availability of marijuana in that community and the demand for marijuana in nearby communities. For some of the 83 cities and towns included in the primary analysis, local tax revenue estimates fluctuated dramatically based on these community-level effects (for example, from about $992,000 to $108,000).

In general, the modeling efforts described here estimate that adult-use marijuana sales are driven primarily by the availability of dispensaries and the potential for medical marijuana dispensaries to expand and/or convert operations to include adult-use marijuana sales. The increase in revenue will largely be a result of retail purchases made by adults with heavy use (defined as consuming marijuana an average of 21 days or more each month). It is difficult to speculate what regulatory costs/benefits may have already been realized when Massachusetts implemented a medical marijuana program. For example, if revenue changes have already been realized, the assumption could be inflating some of the revenue projections by 7-28%. While it is important to consider all aspects of the fiscal impact of legalization, the estimated increase from sales and business tax revenue appear to be most significant.